Salt Pond Waterbird Surveys Data Summary
October 2011 - September 2012

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report serves as a data summary and preliminary, coarse-scale assessment of waterbird and water quality monitoring efforts at Coyote Hills, Dumbarton, and Mowry salt pond complexes in the South San Francisco Bay. These salt ponds are owned by the Don Edwards San Francisco Bay National Wildlife Refuge and managed for salt production by Cargill Salt. Data were collected between October 2011 and September 2012 by the San Francisco Bay Bird Observatory.

The purpose of this ongoing study is to describe avian use of Cargill-managed salt ponds and to use the information gathered to inform regional waterbird conservation, management, and habitat restoration efforts. The South Bay Salt Pond Restoration Project (SBSPRP) has begun to restore over 15,000 acres of former salt evaporation ponds to a mix of tidal marsh and ponded wetland habitats. As the SBSPRP proceeds, understanding how waterbirds use salt ponds, identifying key habitat associations, and incorporating features needed by pond-dependent species into restoration design plans will be increasingly important in retaining baseline numbers of waterbirds in the South Bay.

Monthly waterbird surveys and water quality sampling were conducted at 22 Cargill-managed salt evaporation ponds. Species richness, abundance, and behavior of waterbird assemblages were examined within and between salt pond complexes. Species were also grouped into guilds (e.g., dabbling ducks, diving ducks, fisheating birds, gulls) based on foraging methods and known prey requirements to gain further insights into waterbird use of these salt ponds.

Overall, 324,398 waterbird sightings of 69 species were recorded (all sites combined). The Coyote Hills complex supported the highest overall bird count (141,553 sightings of 61 species), followed by the Mowry and Dumbarton complexes, with 101,989 sightings of 47 species and 80,856 sightings of 49 species, respectively. Guilds appeared to use the ponds in different ways. Abundance distributions of most guilds were patchy, suggesting differential habitat use. This is not surprising given that water quality parameters, such as salinity, varied widely and likely affected prey distributions of foraging birds. For example, we rarely found fisheating birds feeding in high salinity (>120 ppt) ponds, presumably because fish species cannot tolerate high salinities. Similarly, we often observed Eared Grebes, phalaropes, and shorebirds foraging in moderate to high salinity (>60 ppt) ponds, where certain prey items, such as brine shrimp and flies, may be available. In some ponds, high proportions of birds were observed on islands, levees, and manmade structures (e.g., blinds, fence posts) offering roosting or nesting habitat, so these features may be equally important in explaining some guild distributions. Further study of habitat use versus availability is needed to draw formal conclusions about habitat selection by any particular species or guild.

As the SBSPRP progresses, we advocate for a precautionary approach to waterbird management and a strategy that includes maintaining some of the ponds within the project footprint at a variety of salinity levels and water depths suitable for many different guilds. Special consideration should be given to birds that prefer medium to high salinity ponds, such as phalaropes and Eared Grebes, since planned restoration activities will reduce the prevalence of these habitat conditions. Providing sufficiently low water levels in some ponds will be important for foraging shorebirds during migration, and creating or maintaining islands or undisturbed levees will provide potential roosting habitat. As the restoration advances, continued monitoring of avian use of both Cargill-managed and SBSPRP ponds alike will be valuable in assessing progress toward the management target of maintaining current waterbird

numbers. However, a landscape perspective may be needed to tease apart the multitude of factors affecting observed waterbird assemblages on the salt ponds and to interpret changes in bird numbers operating at different temporal and spatial scales.

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In 2002, the U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW, formerly California Department of Fish and Game) entered into an historic agreement with Cargill Salt to acquire 15,100 acres of salt evaporator ponds in the South San Francisco Bay. The South Bay Salt Pond Restoration Project (SBSPRP) has begun to restore the area to a mix of tidal and ponded habitats and to provide flood protection and public access to many sites.

Salt ponds have been present in the San Francisco Bay for over 150 years (Ver Planck 1958) and have significant wildlife value (Anderson 1970, Accurso 1992, Takekawa et al. 2001, Warnock et al. 2002). Due to the loss of wetlands elsewhere, salt ponds now provide important foraging and roosting areas for many waterbirds. As a major migratory and wintering location along the Pacific Flyway, the San Francisco Bay supports more than a million birds throughout the year (Page et al. 1999, Warnock et al. 2002). The SBSPRP has committed to retaining some salt pond habitat (as managed ponds) within the project area for waterbirds, but information is needed to ensure that habitat requirements of large numbers of waterbirds can be met with reduced Cargill-managed salt pond acreage.

The objectives of this ongoing study are to document avian use of salt production ponds in the South San Francisco Bay and to use data collected on waterbird abundance, distribution, and habitat associations to inform regional conservation, management, and habitat restoration efforts. Currently, two entities (the U.S. Geological Survey (USGS) and the San Francisco Bay Bird Observatory (SFBBO)) conduct monthly waterbird surveys and water quality sampling at South Bay salt ponds. The USGS monitors those ponds located within the SBSPRP footprint, while SFBBO monitors those ponds owned by the Don Edwards San Francisco Bay National Wildlife Refuge (the Refuge) and managed by Cargill Salt for salt production; the latter ponds are not part of the SBSPRP. As the SBSPRP proceeds, understanding how waterbirds use salt production ponds, identifying key habitat associations, and incorporating features needed by pond-dependent species into restoration design plans will be increasingly important in retaining baseline numbers of waterbirds in the South Bay.

This report summarizes the preliminary results of SFBBO's surveys in the Coyote Hills, Dumbarton, and Mowry salt pond complexes (Cargill-managed ponds) from October 2011 through September 2012.

METHODS

Study Area

The study area included 22 salt ponds in the city of Fremont, Alameda County, California. Although the ponds are owned by the Don Edwards San Francisco Bay National Wildlife Refuge, Cargill Salt retains salt-making rights and regulates water (referred to as *brine* by Cargill Salt) flow for salt production. The ponds monitored by SFBBO included Coyote Hills ponds (N1A-N9), Dumbarton ponds (NPP1, N1-N3), and Mowry ponds (M1-M6) (Fig. 1). The salinity and depth of these ponds varied over the course of the year due to Cargill management practices and business needs.

Waterbird Surveys

Monthly waterbird surveys were conducted at each of the 22 ponds in the Coyote Hills, Dumbarton, and Mowry salt pond complexes. Surveys were performed exclusively at high tide, defined as a tide of 4.0 feet or greater at the Alameda Creek Tide Sub-Station (37° 35.7' 122°). During each survey, birds were observed from the nearest drivable road or levee using spotting scopes and binoculars. Birds present on the ponds were counted and their locations recorded using aerial site photos superimposed with 250 m^2 individually labeled grids. For each grid-scale sighting of an individual bird or bird group of the same species, behavioral data (whether the bird or bird group was foraging or roosting) were also recorded. For roosting birds only, whether the bird or bird group was seen on a levee, island, or manmade/artificial structure (e.g., blind, fence post) was noted.

Birds were identified to the species level whenever possible, with the exception of Long-Billed and Short-Billed Dowitchers (identified as Dowitchers), and Greater and Lesser Scaup (identified as Scaup). When species identification was not possible, birds were identified to genus or foraging guild (e.g., gulls, small shorebirds, medium shorebirds, phalaropes).

Water Quality Sampling

During each bird survey, a water sample was collected and salinity determined using a hydrometer (Ertco, West Paterson, NJ) in combination with a temperature reading from the pond. Water samples were collected at the same location at each pond every month. Water depth was also recorded by reading the water level on staff gauges (present in all but a few ponds). At low water levels, observers also visually estimated the proportion of any pond substrate exposed to the air to provide a finer-scale characterization of habitat variability.

In addition to the salinity, temperature, and pond depth readings taken during bird surveys, water quality was sampled separately at all 22 salt ponds each month. Dissolved oxygen, salinity, pH, and temperature were recorded at 1-4 pre-determined sampling sites at each pond. Barometric pressure was also recorded at the beginning of each day that water quality samples were taken. A Hydrolab Minisonde (Hydrolab-Hach Company, Loveland, CO) was used to collect water quality measurements. When salinities exceeded ~72 ppt, salinity was determined by measuring specific gravity with hydrometers (Ertco, West Paterson, NJ) and recording the temperature of the pond. All meters were calibrated before the start of sampling. Refer to Murphy et al. (2007) for detailed water quality monitoring methods.

Water quality sampling sites at pond N6 could not be accessed in April and August due to low water levels/mud and thick algal mats, respectively; therefore, no water quality data are available for N6 during those months.

Data Summary

Species Richness. Species richness was calculated as the total number of waterbird species observed (with Dowitchers and Scaup each counting as one "species" since individual species were not distinguished for those taxa) at each pond and pond complex across all surveys from October 2011 to September 2012.

Abundance. Abundance was calculated as the sum of all bird sightings for each species or guild encountered across all surveys from October 2011 to September 2012. Abundance was calculated at the pond, complex, and 250 m^2 grid levels. Due to site fidelity of many birds, we believe that the same individuals were likely re-sighted on surveys close together in time and space, so abundance estimates in this report should be interpreted carefully. As treated here, abundance estimates represent aggregated ground counts, or the total bird sightings (as summed across all surveys) for a given location and period of time.

Behavior. Of the total bird sightings (across all surveys), the proportions observed foraging, roosting, and resting on islands, levees, and manmade structures were calculated for each pond. These proportions were also examined at the guild level (see *Guilds* below).

Guilds. Each species was categorized into a foraging guild based on foraging methods and prey requirements (Appendix I). Guilds of primary interest included dabbling ducks (dabblers), diving ducks (divers), Eared Grebes, fisheating birds (fisheaters), gulls, herons and egrets, medium shorebirds, phalaropes, small shorebirds, and terns. Abundance was calculated by guild for each 250 m^2 grid within the survey area. These counts were then used to create guild-specific maps of abundance distributions using ArcGIS software (version 10, ESRI, Redlands, CA). Guild abundance was also examined by complex, season, and year. Years were defined as Year 0: October 2005 to September 2006, Year 1: October 2006 to September 2007, Year 2: October 2007 to September 2008, Year 3: October 2008 to September 2009, Year 4: October 2009 to September 2010, Year 5: October 2010 to September 2011, and Year 6: October 2011 to September 2012. Seasons were defined as fall (September, October, and November), winter (December, January, and February), spring (March, April, and May), and summer (June, July, and August). Due to the reporting period structure of October 2011 to September 2012, this means that data collected in September 2012 were lumped together with data from October 2011 and November 2011 for fall, a convention that could be changed in future reports.

Water Quality. Monthly salinity, temperature, dissolved oxygen, and pH were calculated for each pond by averaging values taken across all sampling locations within that pond during that period. For the purposes of this report, and for consistency with past SFBBO reports, we confined our summary to full monthly water quality sampling events (i.e., sampling not associated with individual waterbird surveys). For each complex, average salinity was calculated for each season (using the season definitions above). In addition, for discussion purposes, each pond was characterized as low (0-60 ppt), moderate (61-120 ppt), or high (>120 ppt) salinity by averaging monthly means across the study period.

RESULTS & DISCUSSION

Overall, 324,398 waterbird sightings of 69 species were recorded in Cargill-managed salt ponds from October 1, 2011 to September 30, 2012 (Table 1). The Coyote Hills complex supported the highest overall bird counts, followed by Mowry and Dumbarton complexes (Table 1, Fig. 2). Most guilds showed patchy abundance distributions (Figs. 3-12), suggesting differential use of habitat within and between ponds. This is consistent with findings of previous SFBBO reports examining waterbird use of Cargill ponds (e.g., Murphy et al. 2007, Robinson-Nilsen et al. 2009, Robinson-Nilsen and Demers 2012).

Water depth and water quality parameters likely affected prey availability of foraging birds and contributed, at least in part, to observed guild distribution patterns (see Valasquez 1992, Warnock et al. 2002, Takekawa et al. 2006). Birds were seen foraging and roosting in all complexes to varying degrees, and at some ponds, particular guilds used islands, levees, and manmade structures extensively for resting (Table 2). Some guilds, such as gulls and terns, nested on islands and levees within the salt ponds. Many guilds also exhibited intra- (Figs. 13-15, Figs. 16-21 b) and inter- annual (Figs. 16-21 a, c) fluctuations in abundance. Seasonal differences are to be expected for many species, such as migratory shorebirds and waterfowl, and a larger landscape context will be needed for separating annual variation and site-level changes from population-level phenomena.

Due to their connectedness (Figs. 22-25), Cargill-managed salt ponds in the same general area exhibited similar water quality patterns. As water moved through the salt pond complexes, salinity tended to increase (Table 3, Figs. 26-27). The northern Coyote Hills ponds were the freshest ponds monitored in the study area, while the easternmost ponds of the Mowry Complex were the most saline (Table 3, Fig. 26-27). Some seasonal fluctuations were evident in water temperatures (Table 4, Fig. 28). Since cold water tends to hold more dissolved oxygen than warm water, some ponds showed higher dissolved oxygen concentrations in winter months than in summer months (Fig. 29). Influxes of water from rainfall and Cargill management practices, time-of-day effects, algal blooms, and rates of photosynthesis and respiration by aquatic biota may also have contributed to fluctuations in water quality parameters. The latter three factors can be particularly important determinants of dissolved oxygen levels and pH (Carpelan 1957). Ponds N3A, N6, M1, and M2 exhibited larger fluctuations in pH and dissolved oxygen than most of the other ponds (Tables 5-6, Figs. 29-30), probably because water quality could only be sampled from one site each at these locations; at other ponds, water quality parameters were averaged across 2-4 sampling sites.

Coyote Hills

Species Richness, Abundance, and Behavior. Highest species richness and total waterbird abundance were documented in the Coyote Hills complex, with 141,533 sightings of 61 species recorded from October 1, 2011 to September 30, 2012 (Table 1). Coyote Hills salt ponds contained 44% of all sightings and comprised 38% of the total study area (Table 1). Ponds N2A, N3A, and N4AB (Cargill *Concentrator 4A*) were the most used ponds based on overall bird counts. The Coyote Hills complex supported the highest proportions of dabblers (48%), divers (63%), fisheaters (85%), gulls (48%), herons and egrets (76%), medium shorebirds (57%), and terns (88%) (Fig. 31), though it is important to note that herons and egrets and terns had low counts overall (1,556 total sightings and 2,652 total sightings, respectively).

Water Quality. The Coyote Hills complex was characterized by low salinities (Fig. 26), with the northern ponds being less saline than the southern ponds (Fig. 27). There is a water control structure in N1A that intakes brackish water from the Alameda County Flood Control Channel into the pond system (Fig. 22). As the water moves through the complex, the salinity generally increases. During the current study period, average salinities ranged from 25.37 ppt at N1A in October to 61.21 ppt at N4 in September (Table 3). The northern ponds all experienced a steep drop in salinity in May (Fig. 27). Average temperatures in the Coyote Hills ponds ranged from a low of 10.99°C in N3A in December to a high of 26.38°C in N6 in July (Table 4). Temperatures noticeably spiked in May in the northern ponds and again in August (Fig. 28). Average dissolved oxygen concentrations ranged from a low of 2.62 mg/L in N8 in

July to a high of 18.00 mg/L in N6 in January (Table 5). The pH ranged from a low of 7.70 in N2A in October to a high of 9.49 in N6 in July (Table 6).

Dumbarton

Species Richness, Abundance, and Behavior. We documented 80,856 waterbird sightings of 49 species in the Dumbarton complex from October 1, 2011 to September 30, 2012 (Table 1). Dumbarton salt ponds contained 25% of all waterbird sightings and comprised 19% of the total study area (Table 1). Ponds N1 and NPP1 were the most used based on overall bird counts. The Dumbarton complex supported the highest proportions of phalaropes (70%) and small shorebirds (62%) counted during the study period (Fig. 31), though it is important to note that phalarope numbers were low overall (fewer than 7,000 total sightings).

Water Quality. The Dumbarton complex was characterized by moderate salinities (with the exception of NPP1, which was highly saline), and salinity tended to increase as water moved east within the system (Table 3, Fig. 26). During the current study period, average salinities ranged from 59.97 ppt at N3 in July to 195.25 ppt at NPP1 in July (Table 3). Average temperatures in the Dumbarton ponds ranged from 10.98°C in N1 in December to 24.62°C in NPP1 in September, with a noticeable spike in April (Table 4, Fig. 28). Average dissolved oxygen concentrations ranged from a low of 1.56 mg/L in NPP1 in April to a high of 10.03 mg/L in N3 in January (Table 5). The pH ranged from a low of 7.60 at NPP1 in May to a high of 8.97 at N3 in July (Table 6).

Mowry

Species Richness, Abundance, and Behavior. We documented 101,989 waterbird sightings of 47 species in the Mowry complex from October 1, 2011 to September 30, 2012 (Table 1). Mowry salt ponds contained 31% of all waterbird sightings and comprised 43% of the total study area (Table 1). Ponds M4 and M3 were the most used based on overall bird counts. The Mowry complex supported the highest proportions of Eared Grebes (60%) and geese (77%) (Fig. 31), though overall goose counts were low (fewer than 500 total sightings).

Water Quality. The Mowry complex was characterized by low to high salinity ponds, and salinity increased as water moved east within the system (Table 3, Fig. 26). During the current study period, average salinities ranged from 22.30 ppt at M1 in May to 272.67 ppt at M6 in November (Table 3). Average temperatures ranged from 12.18°C in M3 in January to 28.63°C in M6 in June (Table 4). Average dissolved oxygen concentrations ranged from a low of 1.86 mg/L in M3 in May to a high of 15.17 mg/L in M1 in May (Table 5). The pH ranged from a low of 7.53 at M6 in June to a high of 9.28 at M1 in September (Table 6).

Guilds

Some preliminary evidence of habitat associations by guild is presented below for the current study period. Any inferences are based primarily on the grid-scale guild abundance distribution maps (Figs. 2-12) and corresponding pond-scale water quality and behavioral data presented in Tables 3-6 and 7-16, respectively. Future analyses are planned and will relate water quality data to observed waterbird abundances and distribution. We did not examine habitat selection (e.g., by comparing use with availability) and emphasize caution in interpretation.

Dabblers. Dabbling duck abundance was highest in the northern Coyote Hills ponds N3A and N4AA (Cargill *Concentrator 4A*), Dumbarton ponds N1 and NPP1, and Mowry pond M3 (Fig. 3). These ponds had low to high salinities (Table 3, Fig. 26). At M3 and NPP1, most ducks were observed foraging (83% and 82% of sightings, respectively), whereas ducks used N3A, N4AA (Cargill *Concentrator 4A*), and N1 for a mix of foraging and resting activities (Table 7).

Divers. Diving duck abundance was highest in Mowry pond M1 and northern Coyote Hills ponds N1A, N2A, and N4AB (Cargill *Concentrator 4A*) (Fig. 4). These ponds had low salinities, though ducks appeared to use these ponds primarily for roosting (86-93% of diver sightings) (Table 8). In recent years, the Coyote Hills complex has consistently supported the highest numbers of divers (Fig. 17 a).

Eared Grebes. As the SBSPRP continues, land managers are concerned that the loss of medium and high salinity ponds may impact species like Eared Grebes that depend on these habitats. During the current study period, most of the Eared Grebes observed were in Mowry ponds M3 and M4 and in the Dumbarton ponds, particularly NPP1 (Fig. 5), all of which had moderate to high salinities (Table 3, Fig. 26). The majority of Eared Grebes in M3 were foraging (74%), while M4 and NPP1 supported many roosting birds (88% and 66% of total sightings, respectively) (Table 9).

Fisheaters. We observed most fisheaters in the Coyote Hills complex and in Mowry ponds M1, M2, and M3 (Fig. 6). Sightings were highest in N4AB (Cargill *Concentrator 4A*) and N3A, where most fisheaters were observed roosting on levees (83% and 72% of total sightings, respectively) (Table 10). Fish in the South Bay salt ponds cannot survive in salinities greater than 80 ppt (Carpelan 1957), which limits the salinity range where we would expect to observe fisheating birds foraging.

Terns. Compared to most other guilds, counts of terns were low overall (fewer than 2,700 sightings). Tern abundance was highest in Coyote Hills ponds N1A, N3A, N4AA (Cargill *Concentrator 4A*), and N8 (Fig. 7). Most terns were observed roosting on levees or on posts or other manmade structures at these locations (Table 11). A Caspian Tern colony was located on the levees between N1A and N2A.

Gulls. Gulls were abundant in all complexes, but highest numbers were documented in Mowry ponds M3, M4, and M5 and Coyote Hills ponds N2A, N3A, N6, and N7 (Fig. 8). At most of these locations, gulls were primarily observed roosting on levees or islands (Table 12). This is not surprising given that there were California Gull colonies on levees at M1/M2, M3, M4/M5, N2A/N3A, and N6/N7 and two large, nearby landfills offering foraging opportunities, Tri Cities Landfill and Newby Island Landfill. In 2012, numbers of breeding California Gulls in the South Bay reached an all-time high of 52,172 (Robinson-Nilsen and Demers 2012). Gulls were also seen feeding in high numbers at M4 (52% foraging) (Table 12). M4 is a high salinity pond (Fig. 26), and abundant brine shrimp and brine flies have been observed in this location, so the gulls may be feeding on these invertebrates.

Medium Shorebirds. Medium shorebird abundance was highest in Dumbarton pond N1 and Coyote Hills ponds N1A, N4, and N8 (Fig. 9). At N8, most birds were observed roosting (65%), while at N1 and N4, birds used islands extensively (62% and 77% of sightings, respectively) (Table 13). At N1A, 78% of birds were observed roosting on the levees (Table 13). Shorebird use of salt ponds is highly tide dependent

(Warnock et al. 2001), and many shorebird species in the San Francisco Bay use salt ponds as high tide refugia for roosting and foraging. Therefore, the presence of roosting islands or levees that are closed to public access are integral for shorebirds in salt ponds.

Phalaropes. Phalarope abundance was highest in Dumbarton pond N1 and Mowry pond M4 (Fig. 10). At N1 and M4, most phalaropes were observed foraging (67% and 100% of total sightings, respectively) (Table 14). Like Eared Grebes, land managers are concerned that the loss of medium and high salinity ponds may impact phalaropes, which depend on highly saline bodies of water that host brine flies and brine shrimp (Cullen et al. 1999). In recent years, sightings of phalaropes have fluctuated widely (e.g., 2006: 12,572 total sightings, 2010: 433 total sightings, 2012: 6,539 total sightings; Fig. 20 a). It is difficult to know if habitat changes or sampling techniques are driving these fluctuations. Many shallow ponds in Newark were not, at the time of the study, being managed at high salinity levels, and high salinity ponds in Mowry are likely too deep for phalaropes. In addition, phalaropes migrate through the Bay during a relatively short time period, and we may miss sampling ponds during peak phalarope migration by surveying the ponds only once per month.

Small Shorebirds. Small shorebird abundance was highest in Dumbarton ponds NPP1, N1, and N3 (Fig. 11). At NPP1 and N1, most birds were observed roosting on islands (74% of total sightings at each location), while at N3, 57% of birds were roosting on levees (Table 15). As noted above, islands and levees in the salt ponds may offer high tide refugia for shorebirds in the San Francisco Bay. Small shorebird sightings have declined in recent years at the Cargill ponds, primarily due to reduced sightings at the Dumbarton complex (Fig. 21 a). However, small shorebird increases have been reported during this period by Brand et al. (2011) at SBSPRP locations.

Herons and Egrets. Heron and egret abundance was highest in the Coyote Hills ponds (N1A, N3A, N4, N4AA (Cargill *Concentrator 4A*), N8, and N9) and in Mowry ponds M1 and M2 (Fig. 12), though heron and egret counts were low overall (1,556 total sightings). Birds used these areas for a mix of foraging and roosting activities. N1A and N9 were among low salinity ponds (Table 3, Fig. 26) and may support fish and invertebrate prey; 83% of birds observed were foraging at N1A, and 68% of birds observed were foraging at N9 (Table 16).

Considerations for Future Study

We emphasize that this report serves as a data summary and preliminary, coarse-scale assessment of waterbird and water quality monitoring efforts at Cargill-managed ponds. In general, more advanced analyses are needed to tease apart complex temporal and spatial patterns operating at different scales within this dynamic system. Analyses considering both Cargill-managed ponds and SBSPRP (USGS surveyed) areas together will be especially informative. For example, examining annual decreases at Cargill-managed ponds coupled with corresponding increases at SBSPRP ponds (or vice versa) could indicate that the South Bay salt ponds operate as a single complex for certain species or guilds (Murphy et al. 2007). For other species, changes in numbers may be driven by factors operating on much larger (e.g., Pacific Flyway) geographic scales (Murphy et al. 2007).

In a complementary study known as the *Historical Waterbird Project*, an effort is underway by SFBBO, USFWS, USGS, and University of California-Davis (and funded by the USFWS Refuges Inventory and Monitoring Program) to compare aerial waterbird counts conducted in the 1980s to current waterbird ground counts in South Bay salt ponds. In recent months, the topic of local bird movement and its effect on our ability to assess true waterbird abundance within the salt ponds has generated some interesting discussion among agency, academic, and nonprofit biologists, statisticians, and resource professionals. Currently, we (SFBBO and the collaborating entities) do not have the ability to quantify local bird movement in time and space through our ground count methodology, and pond ground counts are not conducted on the same day within a given month due to staff, equipment, and other resource constraints. Nevertheless, quantifying bird movement would seem a valuable addition in determining how closely ground counts reflect true waterbird abundance. In future trials, repeated, staggered counts of the same ponds conducted on the same day by the same observer may be performed to address this issue and to determine if a correction factor should be applied to ground counts to better approximate true waterbird abundance.

For some guilds that migrate through the area rather quickly, such as phalaropes, monthly surveys may not be adequate to accurately monitor their use of salt ponds. More frequent sampling may be required during phalarope migration. Robinson-Nilsen and Demers (2012) suggested intervals of 2-3 days.

In the future, we suggest that additional resources be devoted to examining habitat selection explicitly. This would require comparing use versus availability of different habitat features or characteristics in the Cargill-managed ponds. Additional site information would need to be gathered or obtained. For example, since pond depth likely varies over finer spatial scales than the current staff gauges and visual estimates provide, acquiring bathymetric data would be particularly valuable.

Management Recommendations

The salt ponds of the South San Francisco Bay have long been recognized as an important waterbird migration and wintering site (Takekawa et al. 2001, Warnock et al. 2002). The ponds within the study area are managed for salt production and have widely ranging salinities, water depths, and site features, which influence bird use. In order for the South Bay to retain its current bird numbers, we make the following recommendations for the South Bay Salt Pond Restoration Project's Project Management Team, the Don Edwards San Francisco Bay National Wildlife Refuge, and the California Department of Fish and Wildlife to consider while managing ponds within the restoration project area:

1. Maintain the pond systems to have a variety of water salinities, thereby supporting guilds with different habitat requirements. Special consideration should be given to birds that prefer medium to high salinity ponds, such as phalaropes and Eared Grebes.

2. Provide lower water levels in some ponds for small and medium shorebirds during migration.

3. Provide islands or undisturbed levees for shorebird roosting habitat. This is especially important during high tides.

4. Continue monitoring waterbird use of Cargill-managed and SBSPRP ponds as the project proceeds with its restoration activities. More attention should be given to California Gulls, in particular, and to understanding the dynamics (and consequences for other species) of this rapidly expanding gull population.

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Table 1. Waterbird species richness, abundance (total sightings for all species combined), and acreage by salt pond complex and individual pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

Complex	Pond	Species Richness	Abundance (Total Sightings)	Percent of Total Sightings in Survey Area	Acreage	Percent of Total Acreage in Survey Area
Coyote Hills	N1A	44	10222	3	172.57	3
	N2A	42	17603	5	171.39	3
	N3A	34	30945	10	417.86	6
	N4	37	8916	3	339.64	5
	N4AA*	39	11300	3	299.31	4
	N4AB*	42	16486	5	237.52	3
	N4B	29	3221	1	72.95	1
	N5	29	3178	1	193.36	3
	N6	20	12554	4	94.17	1
	N7	34	10527	3	383.57	6
	N8	31	6457	2	114.133	2
	N9	33	10144	3	128.43	2
	Coyote Hills Total	**61**	**141553**	**44**	**2624.90**	**38**
Dumbarton	N1	38	32796	10	344.73	5
	N2	26	9108	3	193.10	3
	N3	38	16292	5	553.50	8
	NPP1	27	22660	7	195.31	3
	Dumbarton Total	**49**	**80856**	**25**	**1286.64**	**19**
Mowry	M1	42	15065	5	496.541	7
	M2	26	4046	1	485.474	7
	M3	27	26865	8	549.936	8
	M4	18	33803	10	537.50	8
	M5	19	16380	5	415.11	6
	M6	13	5830	2	449.46	7
	Mowry Total	**47**	**101989**	**31**	**2934.02**	**43**
Survey Area Total		**69**	**324398**	**100**	**6845.56**	**100**

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 2. Percentage of total birds foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade
Coyote Hills	N1A	13	47	0	37	4
	N2A	4	34	0	62	0
	N3A	25	12	0	62	0
	N4	4	6	45	45	1
	N4AA*	39	38	3	10	9
	N4AB*	11	33	3	54	0
	N4B	66	20	1	9	4
	N5	25	8	0	56	11
	N6	5	8	0	87	0
	N7	9	5	0	85	1
	N8	5	45	0	51	0
	N9	15	7	7	72	0
Dumbarton	N1	25	19	45	3	8
	N2	46	19	19	15	0
	N3	27	17	17	36	2
	NPP1	36	18	41	5	0
Mowry	M1	14	58	3	25	0
	M2	19	7	55	19	0
	M3	59	17	16	7	2
	M4	46	30	1	23	0
	M5	15	3	49	33	0
	M6	6	26	23	7	38

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 3. The monthly average salinity (ppt) by pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. We were unable to collect water quality data at pond N6 in April and August due to low water levels/mud and thick algal mats, respectively.

		2011			**2012**								
Complex	**Pond**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**
Coyote Hills	N1A	25.37	28.21	29.82	31.31	32.43	34.70	39.92	27.69	30.56	30.69	33.76	32.18
	N2A	28.99	30.47	31.09	32.75	33.95	36.91	39.38	30.08	31.39	33.75	35.31	36.41
	N3A	35.12	35.51	36.12	38.04	37.79	38.81	42.50	31.52	33.64	38.73	42.58	44.04
	N4	49.81	50.27	50.74	51.94	51.15	51.21	52.72	61.21	52.48	55.94	59.11	61.21
	N4AA*	36.57	36.35	37.48	39.16	36.89	37.78	43.72	33.86	35.41	40.21	42.62	44.65
	N4AB*	30.61	31.89	32.53	33.74	34.92	37.53	40.91	30.02	33.47	35.15	36.02	37.37
	N4B	38.51	40.13	41.91	42.98	44.61	44.26	52.43	35.31	36.33	40.70	43.70	47.14
	N5	48.35	48.66	49.14	50.14	48.44	50.28	52.59	55.84	48.94	52.65	55.16	58.41
	N6	42.20	43.29	44.84	46.63	47.53	49.35		37.01	36.72	48.27		52.82
	N7	42.70	43.96	45.55	47.33	47.86	49.71	54.01	49.64	41.31	48.84	52.19	55.13
	N8	40.37	42.32	43.61	45.70	46.70	49.16	52.61	40.62	38.71	47.53	47.71	50.68
	N9	43.34	41.70	42.95	45.17	46.73	48.51	52.22	36.02	35.93	41.66	44.36	50.30
Dumbarton	N1	108.00	115.00	111.00	114.00	106.00	112.00	111.00	143.50	139.25	127.50	125.00	116.50
	N2	81.68	90.75	85.95	89.08	85.15	86.45	87.13	110.25	98.98	92.58	92.38	90.08
	N3	71.78	68.09	68.58	70.75	66.13	66.07	72.51	89.18	78.81	59.97	75.50	74.43
	NPP1	139.00	146.50	144.00	143.00	140.50	138.00	135.50	165.50	160.25	195.25	164.00	139.75
Mowry	M1	40.83	40.53	43.38	28.07	42.00	43.51	49.10	22.30	28.59	28.55	30.91	39.35
	M2	43.71	43.31	44.36	45.78	43.26	43.87	46.37	56.79	54.22	42.52	38.87	41.89
	M3	155.00	144.00	135.00	132.00	122.00	129.50	166.00	175.50	145.50	93.40	101.05	139.00
	M4	179.00	192.33	190.67	184.33	163.33	163.67	167.00	195.33	199.00	119.33	107.67	121.00
	M5	212.50	249.50	228.33	227.00	199.33	201.00	194.33	226.00	234.00	150.33	137.67	150.33
	M6	239.50	272.67	252.67	244.00	224.33	207.00	209.67	247.33	254.67	162.67	178.33	188.67

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 4. The monthly average temperature (degrees Celsius) by pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. We were unable to collect water quality data at pond N6 in April and August due to low water levels/mud and thick algal mats, respectively.

		2011						**2012**					
Complex	**Pond**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**
Coyote Hills	N1A	16.37	11.48	12.26	13.15	13.40	14.33	18.88	22.94	16.41	19.66	24.26	17.92
	N2A	17.36	11.53	11.14	12.56	13.48	16.07	19.45	22.72	16.96	20.42	23.37	18.34
	N3A	16.48	11.64	10.99	13.08	13.20	14.94	19.70	21.50	16.91	18.78	23.79	17.23
	N4	18.46	13.42	13.76	13.67	13.88	18.29	20.83	23.16	19.79	23.39	21.25	19.79
	N4AA*	16.87	11.59	11.87	12.64	13.14	14.46	21.03	20.00	17.04	22.81	25.21	18.72
	N4AB*	17.76	11.07	12.11	12.83	13.28	14.79	20.85	20.47	17.47	21.67	23.50	17.82
	N4B	17.12	11.55	12.51	13.72	13.72	15.42	15.75	18.87	17.80	21.82	20.26	19.35
	N5	17.35	12.35	11.38	12.44	13.10	15.52	20.68	21.94	18.71	21.47	20.66	18.37
	N6	20.33	13.55	12.46	14.02	14.23	17.60		21.26	20.26	26.38		19.56
	N7	17.55	11.20	11.74	11.72	13.06	14.61	21.74	19.27	17.78	23.42	20.95	18.74
	N8	18.38	12.15	11.42	12.47	13.50	16.26	15.86	18.60	19.47	23.73	20.20	18.90
	N9	19.51	12.63	11.99	13.45	13.97	17.49	16.37	20.24	19.63	22.17	20.26	19.30
Dumbarton	N1	20.16	17.19	10.98	14.57	13.95	15.64	21.72	20.02	19.14	21.66	21.58	22.88
	N2	15.76	17.24	12.46	13.61	14.32	18.59	23.59	19.73	22.42	19.33	20.15	20.32
	N3	16.19	17.06	11.42	13.20	14.39	18.90	23.71	20.94	21.80	20.10	20.62	20.00
	NPP1	19.62	16.96	11.36	14.20	14.80	14.29	22.01	20.41	19.47	22.42	22.55	24.62
Mowry	M1	22.21	13.89	14.64	12.48	16.02	17.64	24.77	19.84	24.08	25.74	25.47	23.23
	M2	21.85	14.99	13.95	13.68	15.15	16.06	23.49	17.25	24.80	23.45	23.72	21.43
	M3	18.78	14.48	13.93	12.18	15.64	16.90	23.79	19.60	23.87	24.00	24.56	22.90
	M4	20.92	15.43	12.92	14.06	16.19	19.28	25.64	20.70	27.70	26.23	22.71	24.17
	M5	21.61	14.78	13.01	15.51	16.62	19.20	25.67	20.50	26.92	25.98	22.59	23.09
	M6	22.38	14.71	15.04	14.01	15.93	18.50	26.33	20.40	28.63	24.83	26.65	24.23

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 5. The monthly average dissolved oxygen (mg/L) by pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. We were unable to collect water quality data at pond N6 in April and August due to low water levels/mud and thick algal mats, respectively.

		2011						**2012**					
Complex	**Pond**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**
Coyote Hills	N1A	10.34	6.26	11.70	8.75	8.70	6.95	5.77	7.82	6.66	6.20	7.19	6.81
	N2A	4.43	5.14	9.22	8.04	8.04	6.86	6.90	10.12	6.35	5.74	7.04	6.02
	N3A	5.75	2.74	9.94	10.06	7.86	6.44	3.23	8.12	6.02	3.07	8.59	6.63
	N4	9.27	9.21	9.18	10.25	7.46	8.48	5.08	6.35	6.81	6.49	5.77	6.13
	N4AA*	5.28	3.04	8.23	7.28	7.99	9.31	3.12	6.13	3.92	7.20	7.56	4.15
	N4AB*	12.07	4.87	14.44	15.35	7.67	5.93	5.12	6.93	7.28	6.77	8.23	5.36
	N4B	10.17	6.17	11.38	11.20	9.69	8.42	7.06	7.40	3.63	7.62	6.51	7.00
	N5	8.09	7.57	9.44	11.80	6.76	7.89	4.27	4.69	5.81	5.50	5.07	5.73
	N6	7.16	8.73	6.88	18.00	10.81	11.19		7.57	7.00	11.43		4.48
	N7	6.65	3.64	11.94	13.69	6.80	7.50	6.56	6.01	5.96	7.32	7.90	7.55
	N8	6.10	4.15	11.16	12.40	7.34	7.80	5.16	6.76	6.15	2.62	5.08	5.48
	N9	8.81	5.43	7.92	14.40	7.68	9.18	5.99	7.69	6.83	5.80	4.86	4.31
Dumbarton	N1	6.57	5.13	6.21	7.84	6.18	5.77	2.36	3.90	2.88	2.70	4.63	5.84
	N2	4.38	5.94	7.43	8.96	6.36	7.62	4.54	4.76	4.06	3.78	4.18	6.57
	N3	5.55	7.08	6.95	10.03	8.34	8.04	6.39	6.02	5.44	4.35	3.88	7.02
	NPP1	5.35	5.28	6.26	7.56	7.00	4.91	1.56	5.60	5.00	1.99	2.61	4.39
Mowry	M1	13.47	4.94	13.00	9.32	10.27	4.53	9.95	15.17	9.38	10.43	8.78	10.54
	M2	2.67	7.40	12.02	8.49	11.60	4.54	6.52	6.18	8.25	6.32	7.27	9.67
	M3	5.65	8.48	6.28	4.99	7.06	3.66	10.38	1.86	3.01	4.66	5.43	4.82
	M4	5.88	3.60	7.68	9.22	6.93	7.33	4.42	2.54	2.72	3.28	3.01	2.95
	M5	4.44	3.69	5.73	7.18	8.90	6.08	3.01	2.07	2.88	2.61	3.40	3.85
	M6	4.28	2.86	4.18	3.85	8.63	5.25	3.58	2.19	2.68	2.97	2.08	3.58

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 6. The monthly average pH by pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. We were unable to collect water quality data at pond N6 in April and August due to low water levels/mud and thick algal mats, respectively.

		2011						**2012**					
Complex	**Pond**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**
Coyote Hills	N1A	8.15	7.96	8.19	7.92	8.29	8.22	8.06	7.92	8.04	8.30	8.23	8.03
	N2A	7.70	7.89	8.07	8.24	8.38	8.09	8.09	8.60	8.07	8.18	8.14	8.04
	N3A	8.58	8.06	8.43	8.21	8.75	9.01	8.83	8.59	8.40	8.94	8.78	8.52
	N4	8.65	8.69	8.54	8.57	8.55	8.33	8.18	8.38	8.48	9.09	8.71	8.42
	N4AA*	8.36	8.10	8.29	8.23	8.80	9.05	8.44	8.45	8.37	9.00	8.62	8.20
	N4AB*	8.70	8.39	8.55	8.90	8.53	8.04	7.91	8.05	8.16	8.47	8.40	8.03
	N4B	8.31	8.26	8.43	8.47	8.64	8.53	8.23	8.56	8.16	8.95	8.52	8.37
	N5	8.57	8.58	8.51	8.53	8.43	8.35	8.19	8.42	8.45	9.10	8.68	8.52
	N6	8.10	8.32	8.28	8.56	8.44	8.47		8.52	8.46	9.49		8.29
	N7	8.30	8.24	8.41	8.31	8.18	8.32	8.36	8.54	8.50	9.20	8.82	8.78
	N8	7.94	8.14	8.32	8.41	8.30	8.32	8.18	8.54	8.49	8.30	8.63	8.46
	N9	8.12	8.22	8.30	8.50	8.38	8.42	8.30	8.53	8.40	8.85	8.50	7.88
Dumbarton	N1	8.07	8.15	8.24	8.19	8.40	8.29	8.38	8.19	8.15	8.19	8.03	8.33
	N2	8.52	8.66	8.70	8.85	8.90	8.84	8.79	8.47	8.10	8.70	8.56	8.90
	N3	8.90	8.84	8.84	8.88	8.87	8.59	8.64	8.43	8.37	8.97	8.78	8.86
	NPP1	7.60	7.78	7.95	7.92	8.16	7.94	7.78	7.60	7.88	7.88	7.62	7.85
Mowry	M1	8.45	8.43	8.60	8.21	8.78	8.09	8.77	8.51	8.10	8.04	8.20	9.28
	M2	8.19	8.60	8.77	8.63	8.80	8.52	8.64	8.65	8.85	8.58	8.47	8.34
	M3	7.99	8.40	8.38	8.26	8.30	8.27	8.29	8.00	8.05	8.22	8.54	7.98
	M4	7.81	8.03	8.07	8.18	8.23	8.16	8.03	7.81	7.68	8.00	8.16	8.06
	M5	7.65	7.85	7.89	7.88	8.12	7.98	7.87	7.73	7.62	7.86	8.00	7.97
	M6	7.56	7.73	7.68	7.75	8.02	7.96	7.81	7.64	7.53	7.82	7.73	7.69

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 7. Percentage of dabblers foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of dabbler sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	49	27	0	24	0	409
	N2A	35	65	0	0	0	52
	N3A	45	27	0	28	0	11614
	N4	50	17	33	0	0	12
	N4AA*	45	46	2	4	3	7002
	N4AB*	35	61	0	4	0	1962
	N4B	55	34	0	8	3	519
	N5	52	48	0	0	0	84
	N6	83	11	0	6	0	18
	N7	75	24	1	0	0	185
	N8	66	24	0	10	0	58
	N9	30	2	48	17	2	87
Dumbarton	N1	44	25	27	4	0	6065
	N2	37	14	4	45	0	2494
	N3	42	31	10	16	1	2559
	NPP1	82	11	3	4	0	3866
Mowry	M1	11	74	15	0	0	1041
	M2	0	93	7	0	0	57
	M3	83	13	2	1	0	6815
	M4	60	34	0	6	0	1043
	M5	100	0	0	0	0	221
	M6	80	20	0	0	0	35

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 8. Percentage of divers foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of diver sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	7	93	0	0	0	4114
	N2A	8	92	0	0	0	5397
	N3A	73	26	0	0	0	1254
	N4	5	95	0	0	0	372
	N4AA*	18	82	0	0	0	940
	N4AB*	14	86	0	0	0	3190
	N4B	8	92	0	0	0	138
	N5	10	90	0	0	0	114
	N6	81	19	0	0	0	31
	N7	49	51	0	0	0	388
	N8	24	76	0	0	0	76
	N9	33	67	0	0	0	198
Dumbarton	N1	11	89	0	0	0	1026
	N2	7	93	0	0	0	132
	N3	58	42	0	0	0	252
	NPP1	24	74	0	2	0	410
Mowry	M1	6	94	0	0	0	6669
	M2	3	97	0	0	0	39
	M3	29	71	0	0	0	375
	M4	1	99	0	0	0	623
	M5	0	0	0	100	0	1
	M6	0	0	0	0	0	0

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 9. Percentage of Eared Grebes foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of Eared Grebe sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	0	100	0	0	0	2
	N2A	61	39	0	0	0	84
	N3A	10	90	0	0	0	21
	N4	21	79	0	0	0	14
	N4AA*	80	20	0	0	0	5
	N4AB*	18	82	0	0	0	45
	N4B	0	0	0	0	0	0
	N5	38	63	0	0	0	16
	N6	77	23	0	0	0	30
	N7	92	8	0	0	0	86
	N8	86	14	0	0	0	21
	N9	79	21	0	0	0	80
Dumbarton	N1	38	62	0	0	0	1182
	N2	53	47	0	0	0	2226
	N3	51	49	0	0	0	2186
	NPP1	34	66	0	0	0	3913
Mowry	M1	60	40	0	0	0	10
	M2	29	71	0	0	0	31
	M3	74	26	0	0	0	7314
	M4	12	88	0	0	0	6565
	M5	25	75	0	0	0	602
	M6	23	77	1	0	0	514

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 10. Percentage of fisheaters foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of fisheater sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	22	14	0	33	32	564
	N2A	8	51	0	40	1	1150
	N3A	23	4	0	72	0	2188
	N4	2	6	0	91	1	855
	N4AA*	43	6	0	49	1	899
	N4AB*	6	10	0	83	1	2446
	N4B	69	31	0	0	0	42
	N5	50	5	0	42	2	1216
	N6	12	4	0	84	0	91
	N7	13	4	1	81	1	1023
	N8	4	4	0	91	1	627
	N9	6	3	2	89	0	578
Dumbarton	N1	13	0	88	0	0	8
	N2	0	0	0	0	0	0
	N3	15	58	2	1	25	198
	NPP1	0	0	100	0	0	1
Mowry	M1	23	25	33	16	3	373
	M2	72	12	14	1	0	943
	M3	0	0	0	8	92	561
	M4	0	0	0	0	0	0
	M5	0	0	100	0	0	2
	M6	0	0	0	0	0	0

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 11. Percentage of terns foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of tern sightings during the study period.

Complex	**Pond**	**% Foraging**	**% Roosting**	**% Island**	**%Levee**	**% Manmade**	**N**
Coyote Hills	N1A	17	1	0	38	43	500
	N2A	12	1	0	84	3	162
	N3A	3	0	0	88	9	321
	N4	0	0	66	0	34	129
	N4AA*	1	0	0	1	98	537
	N4AB*	24	1	1	49	25	116
	N4B	90	0	0	0	10	10
	N5	17	0	0	2	80	46
	N6	0	0	0	0	0	0
	N7	1	0	0	88	12	121
	N8	0	0	0	99	1	377
	N9	67	0	0	0	33	3
Dumbarton	N1	0	0	75	3	22	175
	N2	0	0	0	0	0	0
	N3	2	0	49	2	46	41
	NPP1	0	0	0	0	0	0
Mowry	M1	67	0	0	0	33	9
	M2	37	0	0	63	0	43
	M3	55	0	2	44	0	62
	M4	0	0	0	0	0	0
	M5	0	0	0	0	0	0
	M6	0	0	0	0	0	0

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 12. Percentage of gulls foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of gull sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	7	8	0	77	8	624
	N2A	0	1	0	99	0	8649
	N3A	1	1	0	99	0	13020
	N4	8	1	0	91	0	1653
	N4AA*	8	19	2	65	7	327
	N4AB*	0	2	2	95	0	6509
	N4B	35	47	0	12	6	17
	N5	12	8	0	80	0	382
	N6	0	0	0	100	0	10890
	N7	0	3	0	97	0	7194
	N8	2	4	0	95	0	491
	N9	0	1	0	98	0	5235
Dumbarton	N1	44	31	9	10	6	3834
	N2	73	14	2	9	1	1314
	N3	40	6	5	43	6	2205
	NPP1	84	2	10	4	0	1162
Mowry	M1	4	3	1	92	0	1744
	M2	1	6	59	35	0	1284
	M3	34	2	50	14	1	7944
	M4	52	15	1	33	0	23033
	M5	2	1	53	44	0	11941
	M6	1	23	24	7	45	4918

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 13. Percentage of medium shorebirds foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of medium shorebird sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	2	19	0	78	0	3465
	N2A	0	3	0	96	0	1718
	N3A	42	21	0	37	0	903
	N4	0	1	77	22	1	5051
	N4AA*	19	14	10	17	40	647
	N4AB*	7	10	55	28	0	216
	N4B	60	26	0	7	7	1138
	N5	0	0	0	89	10	484
	N6	27	73	0	0	0	1290
	N7	13	2	0	82	3	674
	N8	2	65	0	33	0	4251
	N9	9	29	31	31	0	1252
Dumbarton	N1	4	20	62	1	13	7059
	N2	44	12	33	12	0	249
	N3	34	14	28	23	1	1229
	NPP1	42	36	17	5	0	943
Mowry	M1	12	43	1	44	0	3185
	M2	0	0	50	50	0	403
	M3	46	54	1	0	0	2552
	M4	35	51	4	8	2	130
	M5	30	1	55	1	13	411
	M6	27	0	73	0	0	45

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 14. Percentage of phalaropes foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of phalarope sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	0	0	0	0	0	0
	N2A	0	0	0	0	0	0
	N3A	0	0	0	0	0	0
	N4	0	0	0	0	0	0
	N4AA*	0	0	0	0	0	0
	N4AB*	0	0	0	0	0	0
	N4B	0	0	0	0	0	0
	N5	0	0	0	0	0	0
	N6	0	0	0	0	0	0
	N7	0	0	0	0	0	0
	N8	0	0	0	0	0	0
	N9	0	0	0	0	0	0
Dumbarton	N1	68	9	23	0	0	3734
	N2	100	0	0	0	0	506
	N3	100	0	0	0	0	18
	NPP1	79	20	0	0	0	316
Mowry	M1	0	0	0	0	0	0
	M2	0	0	0	0	0	0
	M3	99	1	0	0	0	473
	M4	100	0	0	0	0	1492
	M5	0	0	0	0	0	0
	M6	0	0	0	0	0	0

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 15. Percentage of small shorebirds foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of small shorebird sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	76	1	0	22	1	392
	N2A	10	47	0	42	0	331
	N3A	39	0	0	60	1	1489
	N4	13	6	3	77	2	686
	N4AA*	74	12	12	0	1	728
	N4AB*	19	50	11	20	0	1935
	N4B	82	2	2	11	3	1317
	N5	2	0	2	66	31	776
	N6	76	20	0	4	0	132
	N7	36	0	2	59	3	770
	N8	17	0	0	83	0	453
	N9	42	2	9	47	0	2571
Dumbarton	N1	5	3	74	3	15	9693
	N2	24	0	71	5	0	2180
	N3	9	6	27	57	2	7528
	NPP1	16	3	74	7	0	12043
Mowry	M1	51	10	7	32	0	1935
	M2	4	0	96	0	0	1072
	M3	25	0	17	52	6	419
	M4	69	0	5	26	0	900
	M5	56	0	43	2	0	3200
	M6	38	1	43	17	0	309

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

Table 16. Percentage of herons and egrets foraging, roosting, and using islands, levees, or manmade structures (e.g., blinds, fence posts) in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. N is the total number of heron and egret sightings during the study period.

Complex	Pond	% Foraging	% Roosting	% Island	%Levee	% Manmade	N
Coyote Hills	N1A	83	1	0	11	5	151
	N2A	90	0	0	10	0	50
	N3A	31	2	0	66	1	128
	N4	45	1	1	54	0	142
	N4AA*	37	8	3	51	1	190
	N4AB*	40	5	13	42	0	62
	N4B	46	6	0	43	6	35
	N5	96	4	0	0	0	54
	N6	76	0	0	24	0	67
	N7	39	10	0	52	0	83
	N8	41	3	0	56	0	103
	N9	68	6	7	18	1	123
Dumbarton	N1	20	0	0	80	0	5
	N2	0	0	0	0	0	0
	N3	82	3	0	15	0	72
	NPP1	0	100	0	0	0	4
Mowry	M1	51	6	3	39	1	98
	M2	11	1	50	39	0	171
	M3	50	0	0	50	0	16
	M4	0	0	0	100	0	1
	M5	0	0	0	0	0	0
	M6	100	0	0	0	0	1

*Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

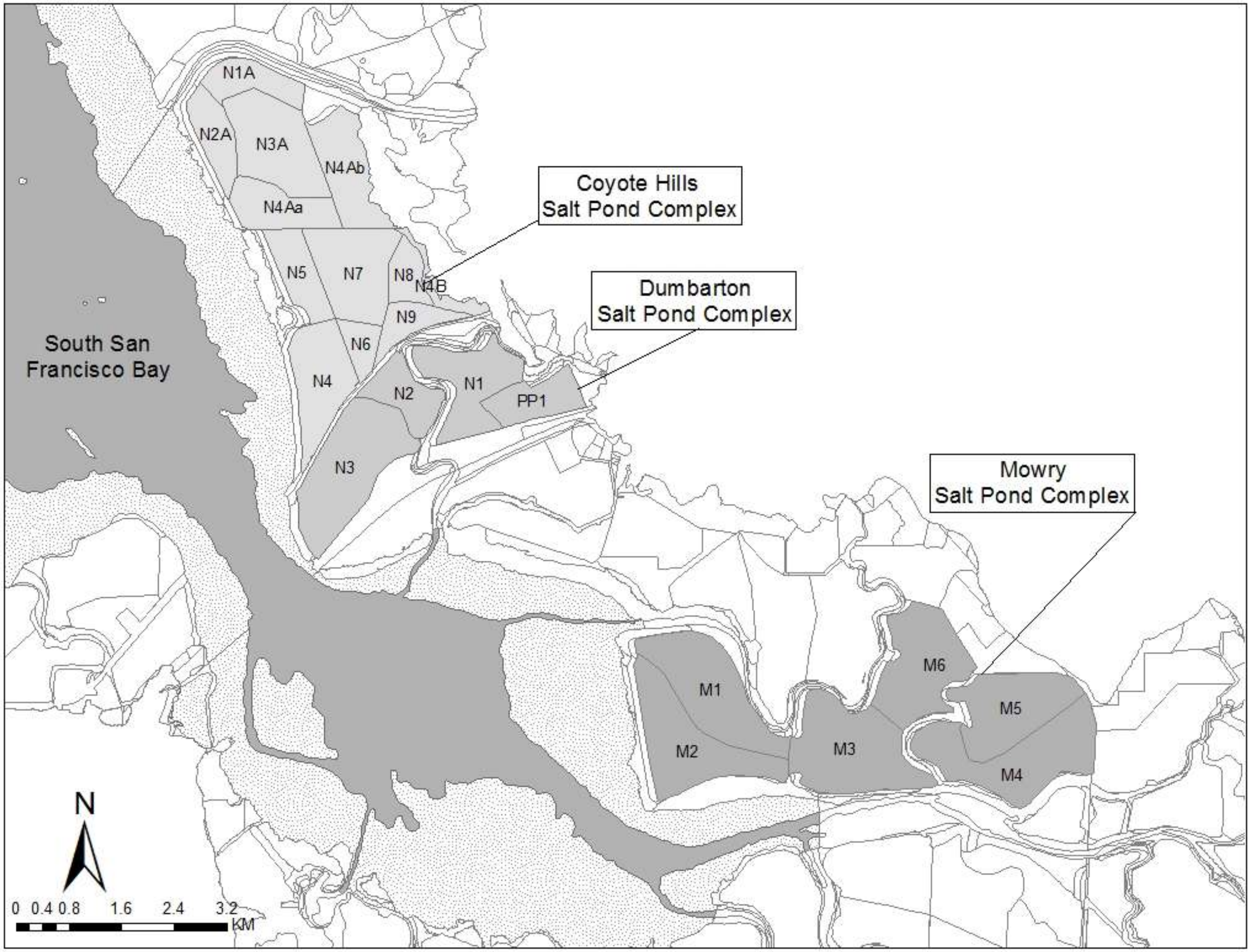


Figure 1. The Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California. Note: Ponds N4Aa and N4Ab are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

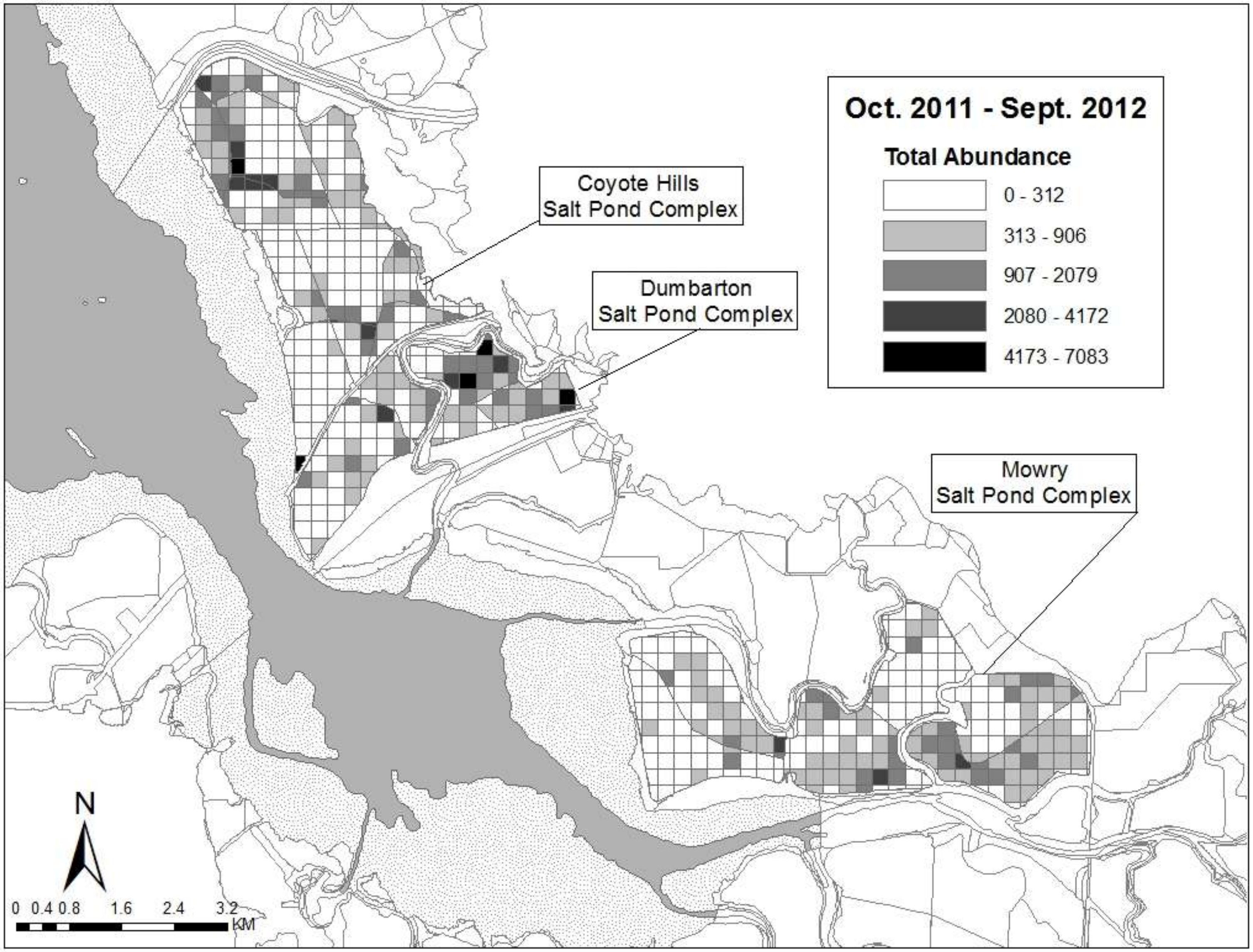


Figure 2. Bird abundance (all guilds) in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

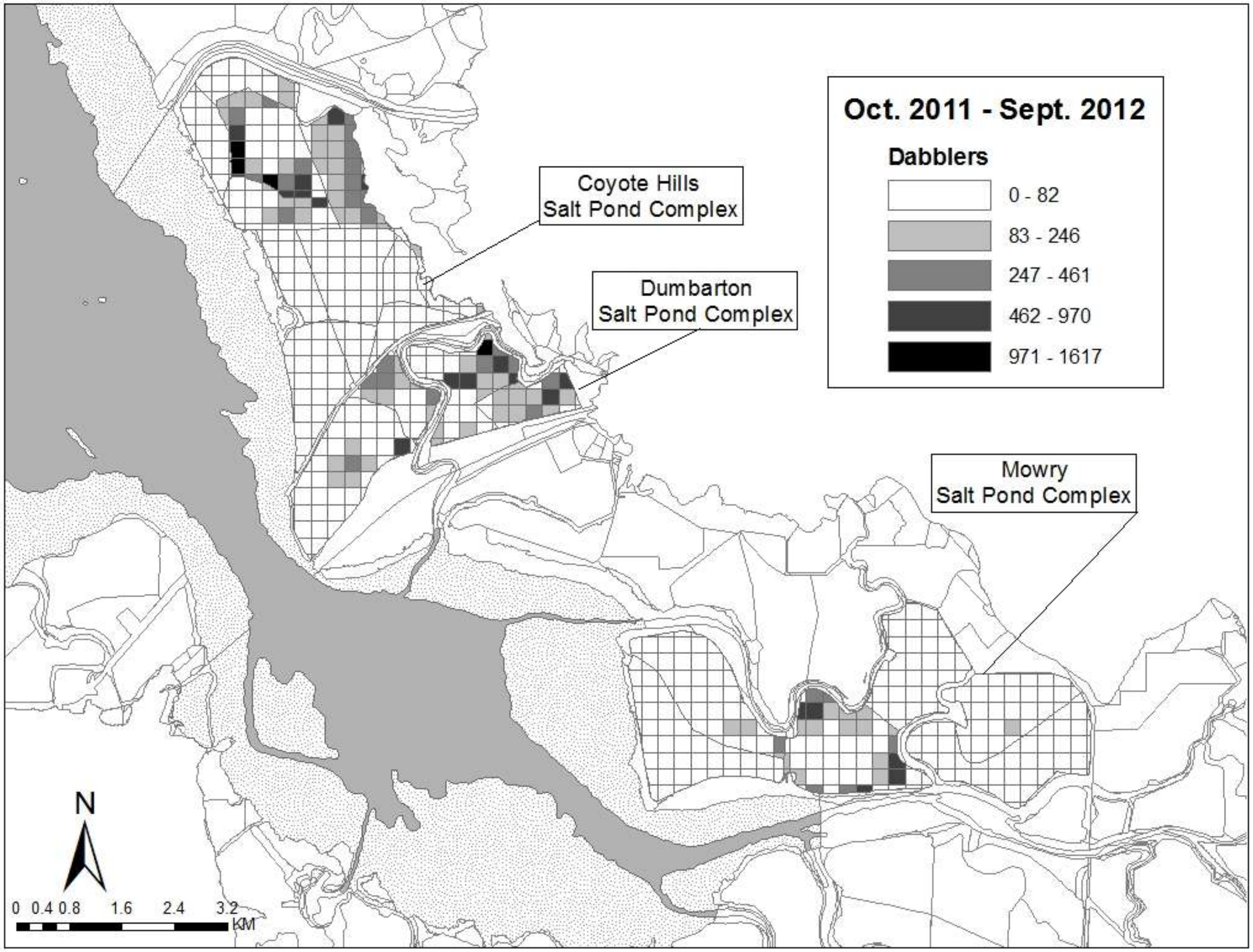


Figure 3. Dabbler abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

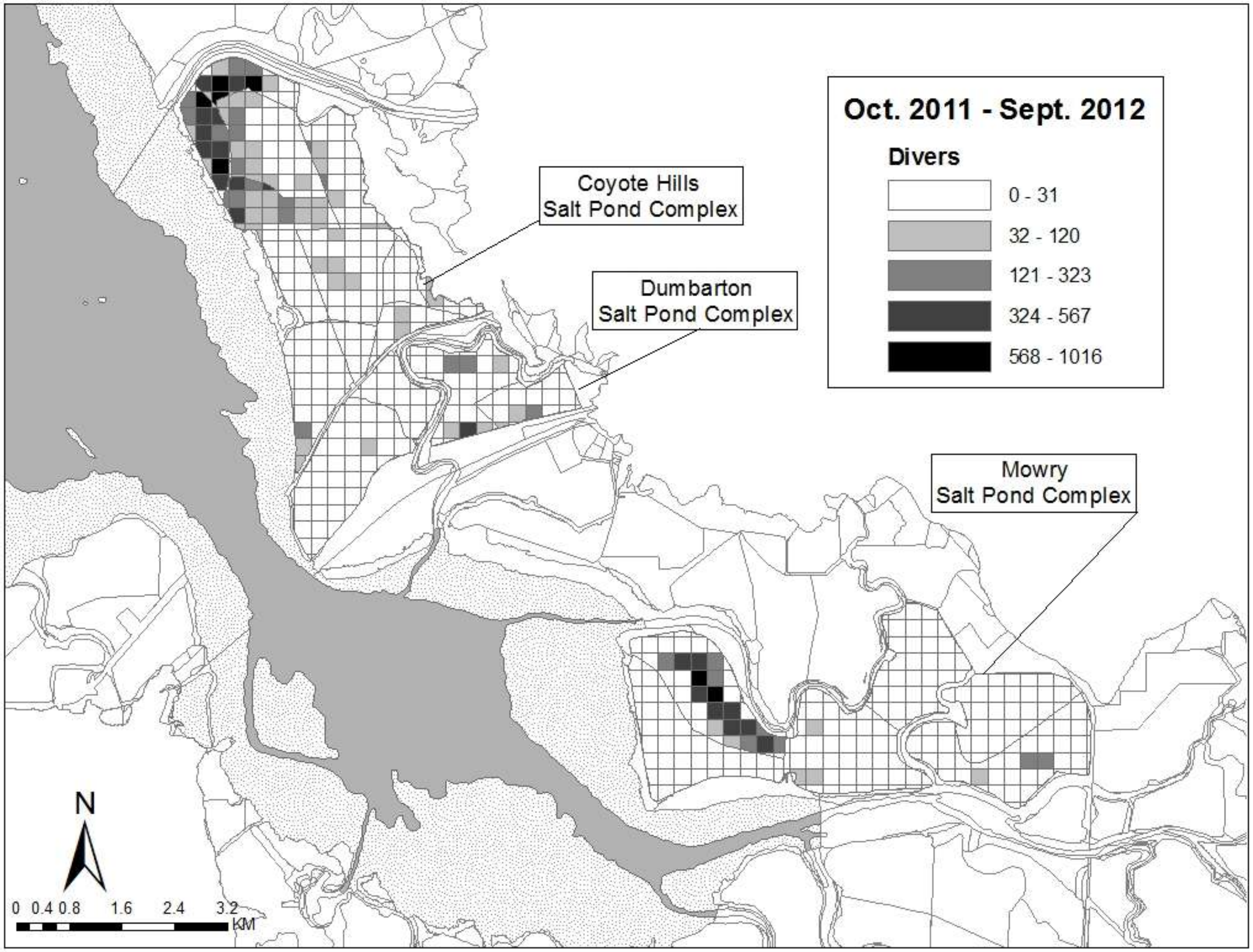


Figure 4. Diver abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

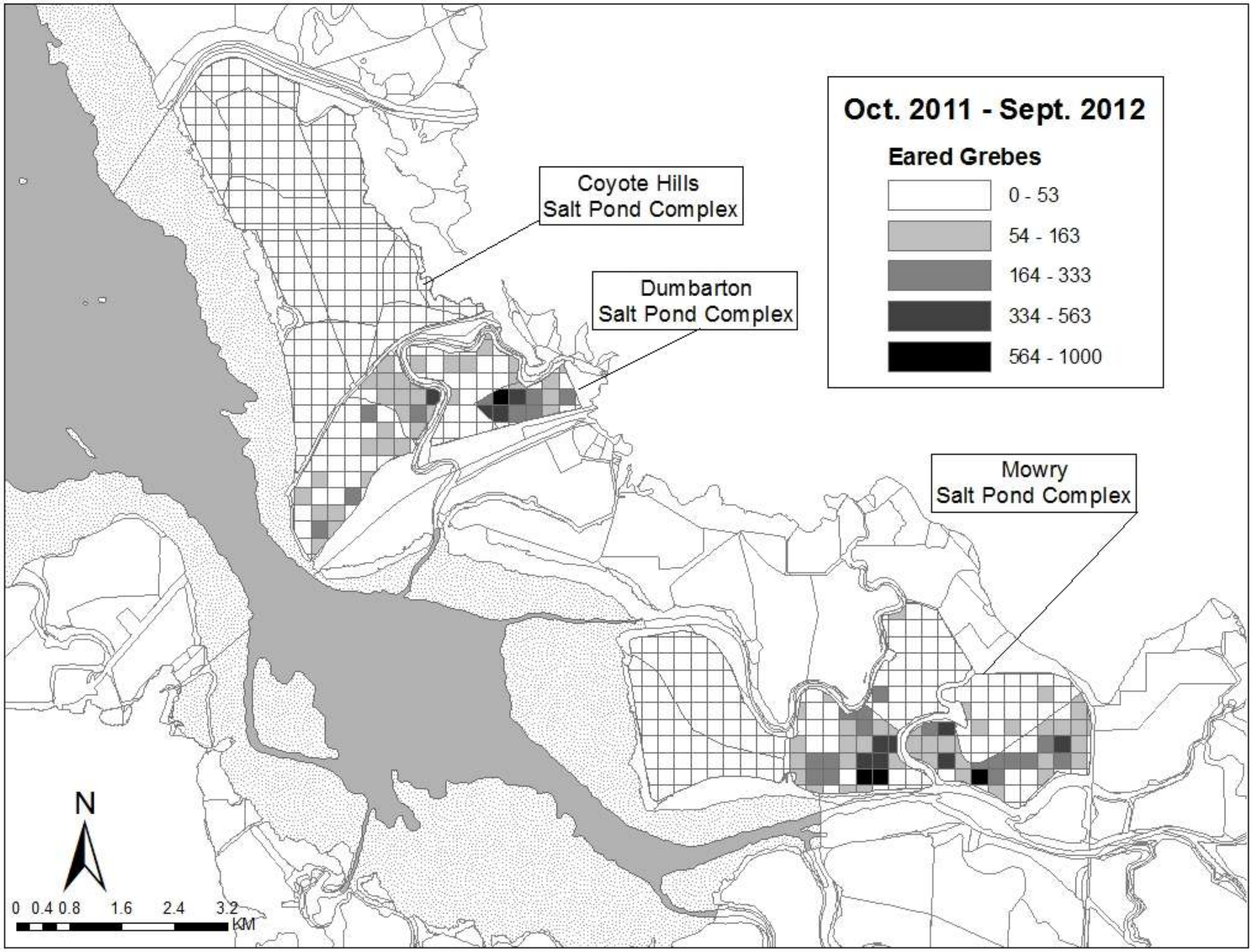


Figure 5. Eared Grebe abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

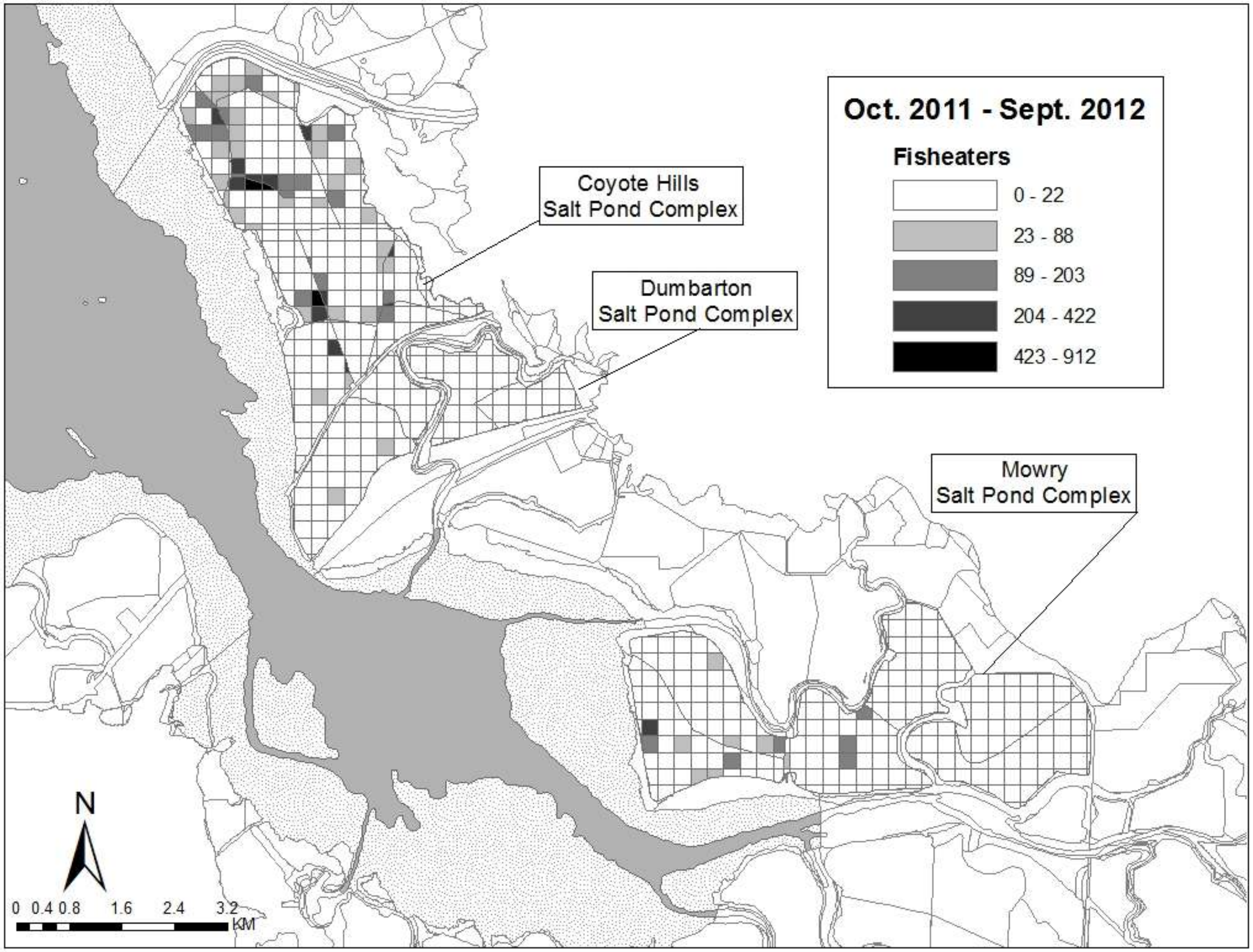


Figure 6. Fisheater abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

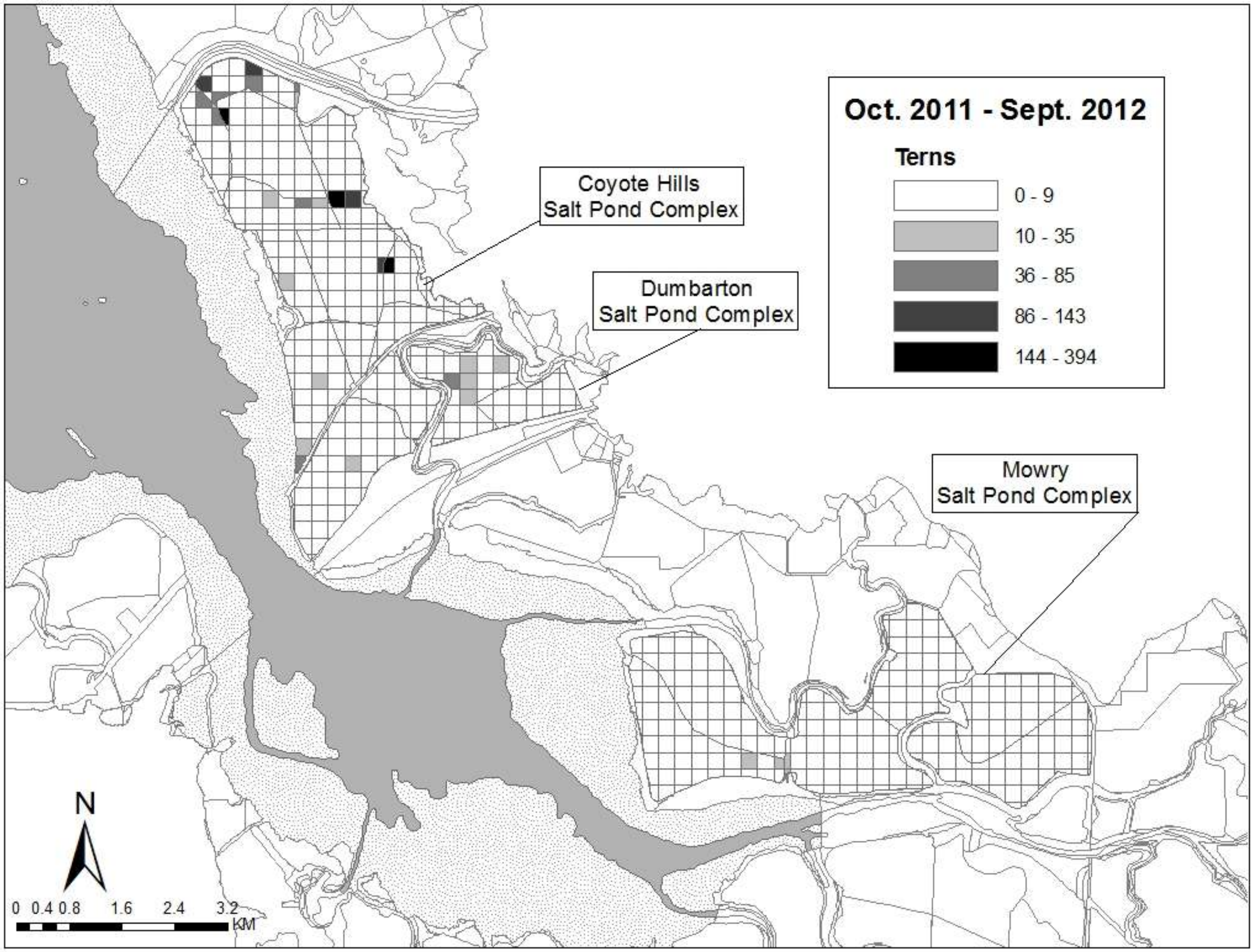


Figure 7. Tern abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

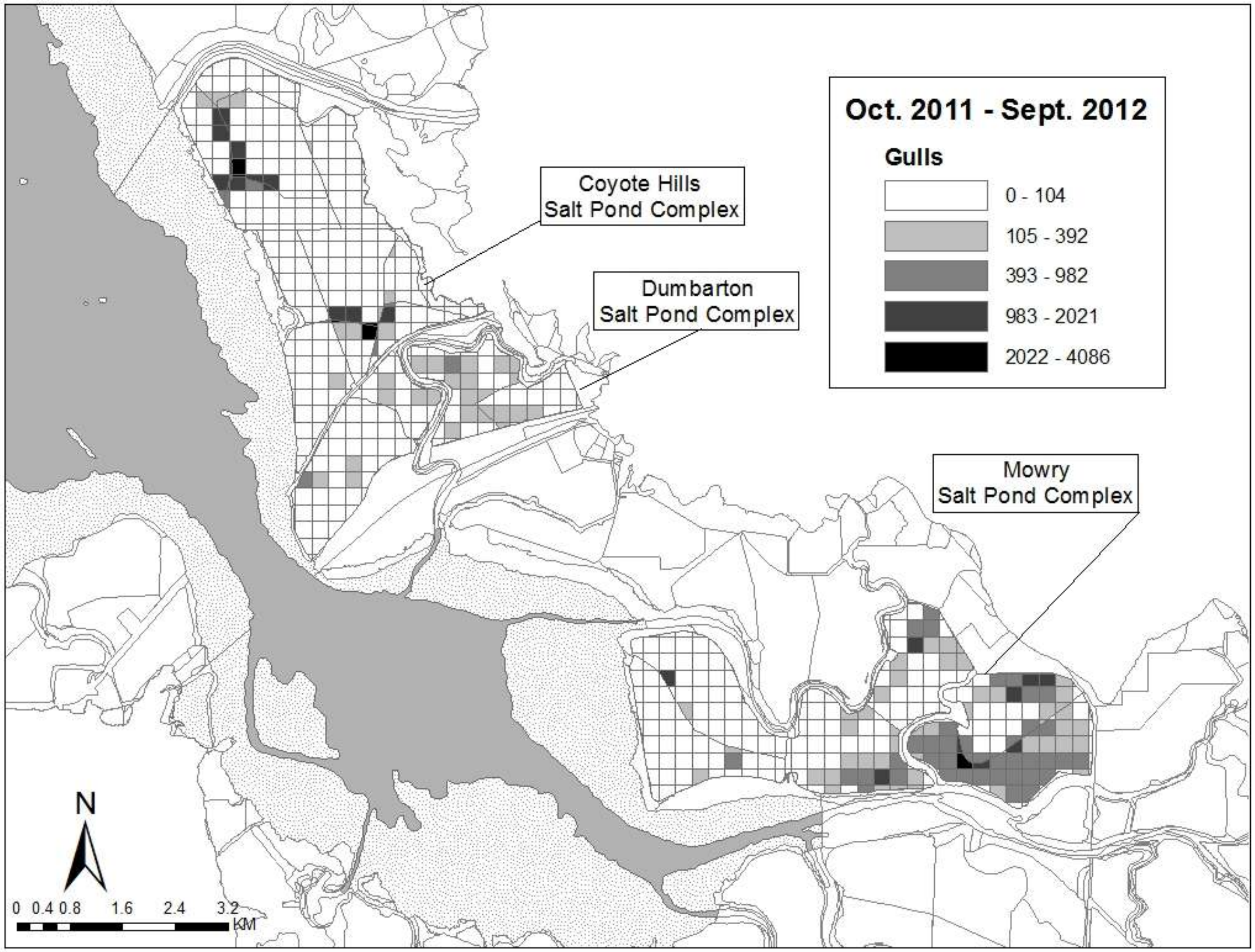


Figure 8. Gull abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

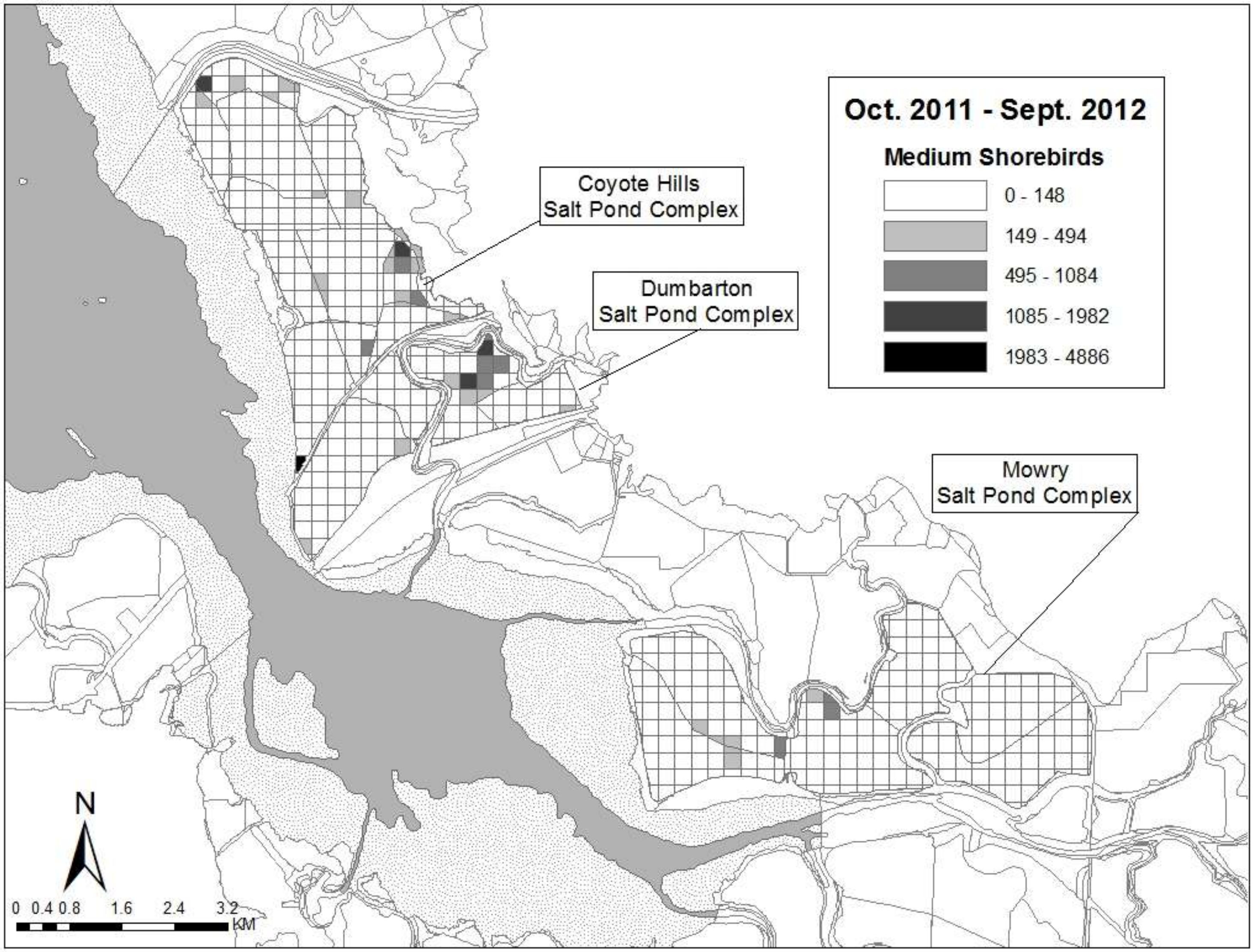


Figure 9. Medium shorebird abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

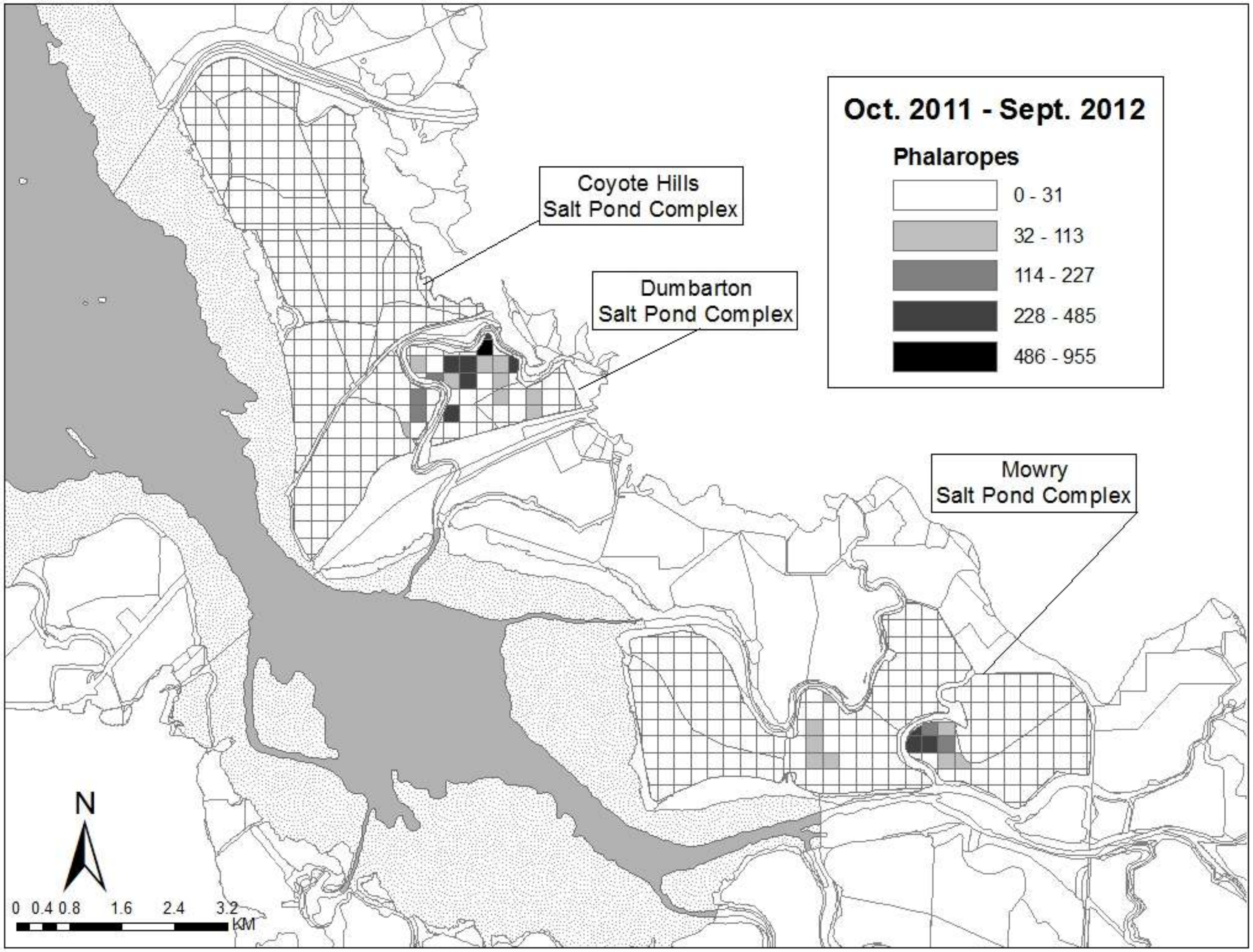


Figure 10. Phalarope abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

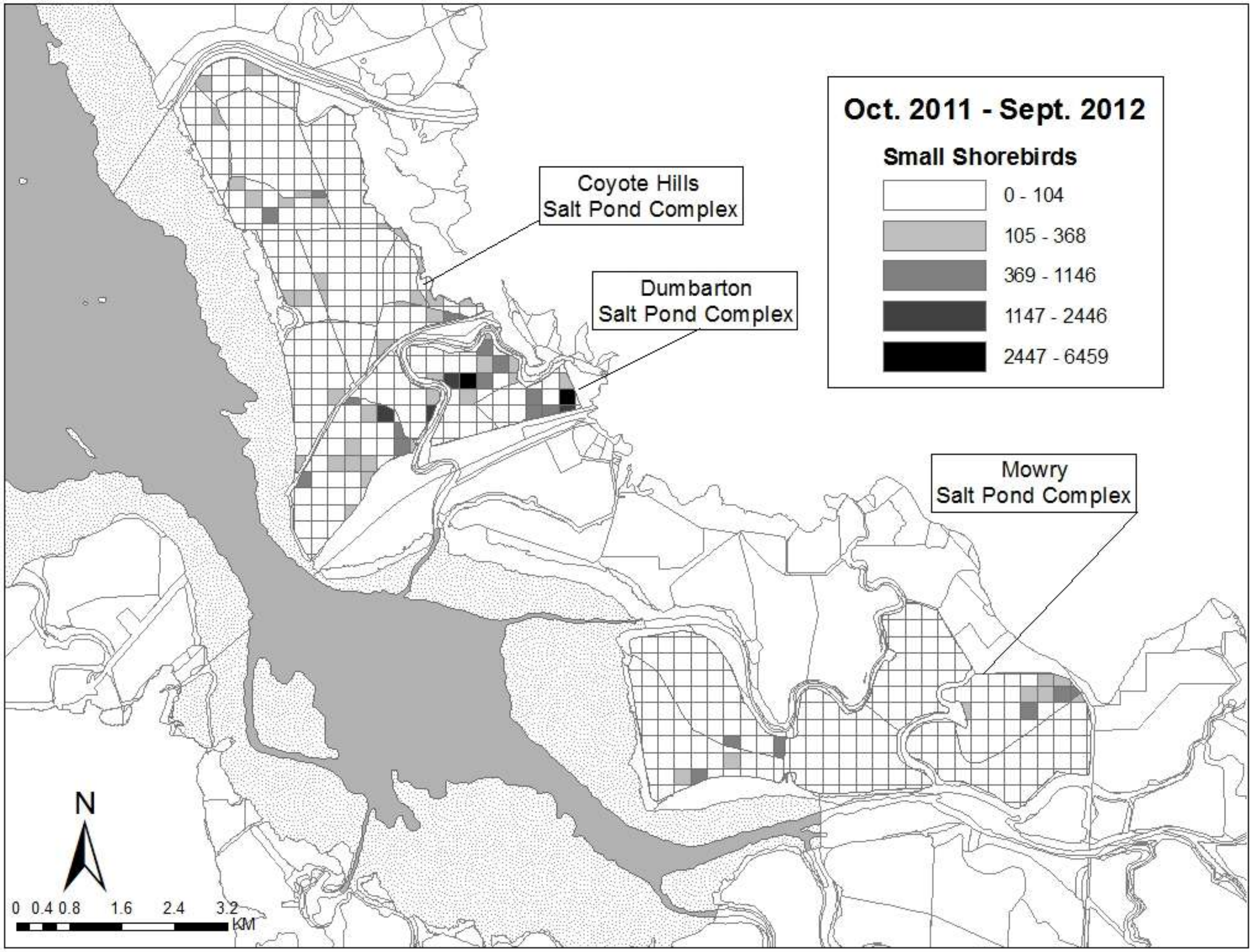


Figure 11. Small shorebird abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

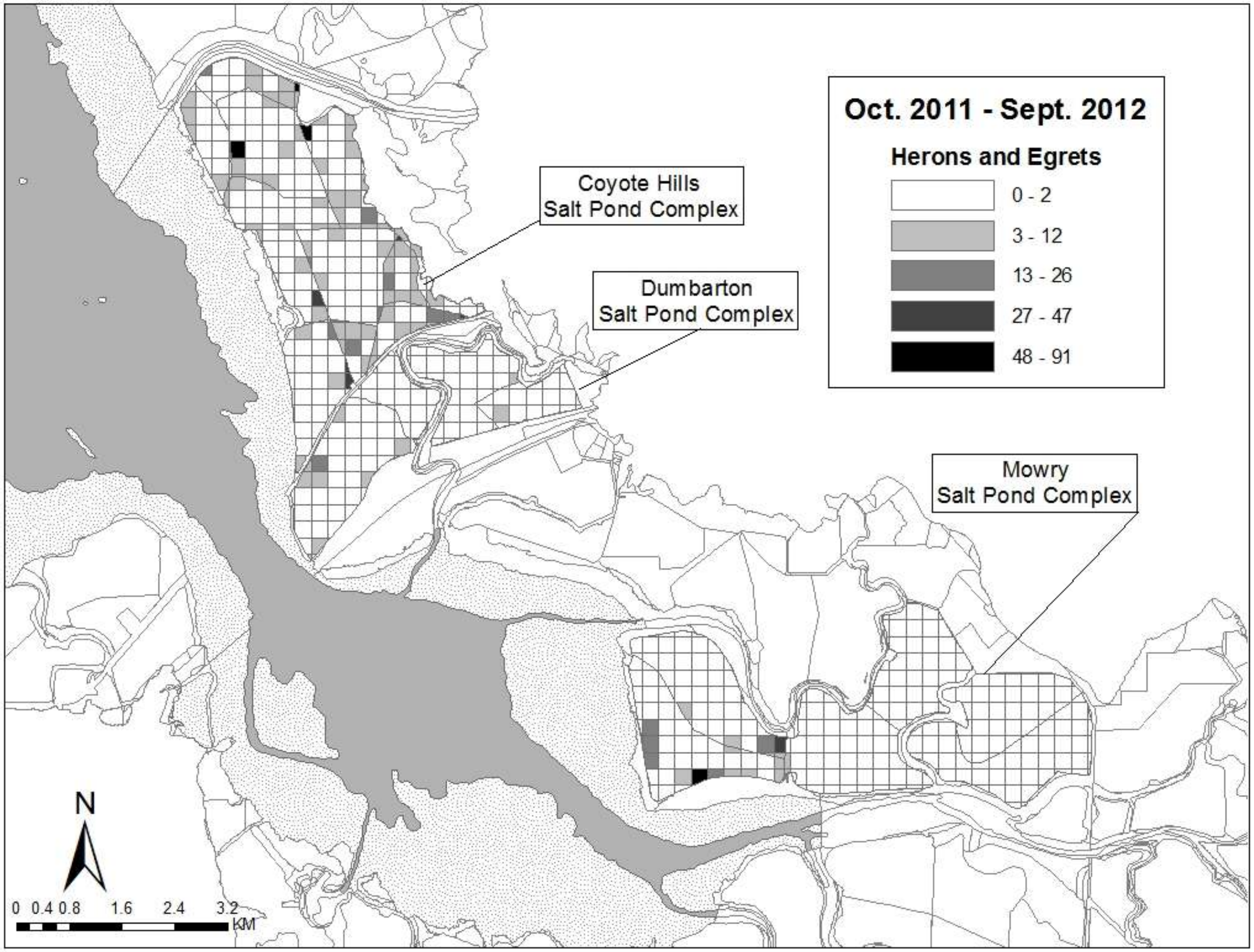


Figure 12. Heron abundance in each 250 m^2 salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

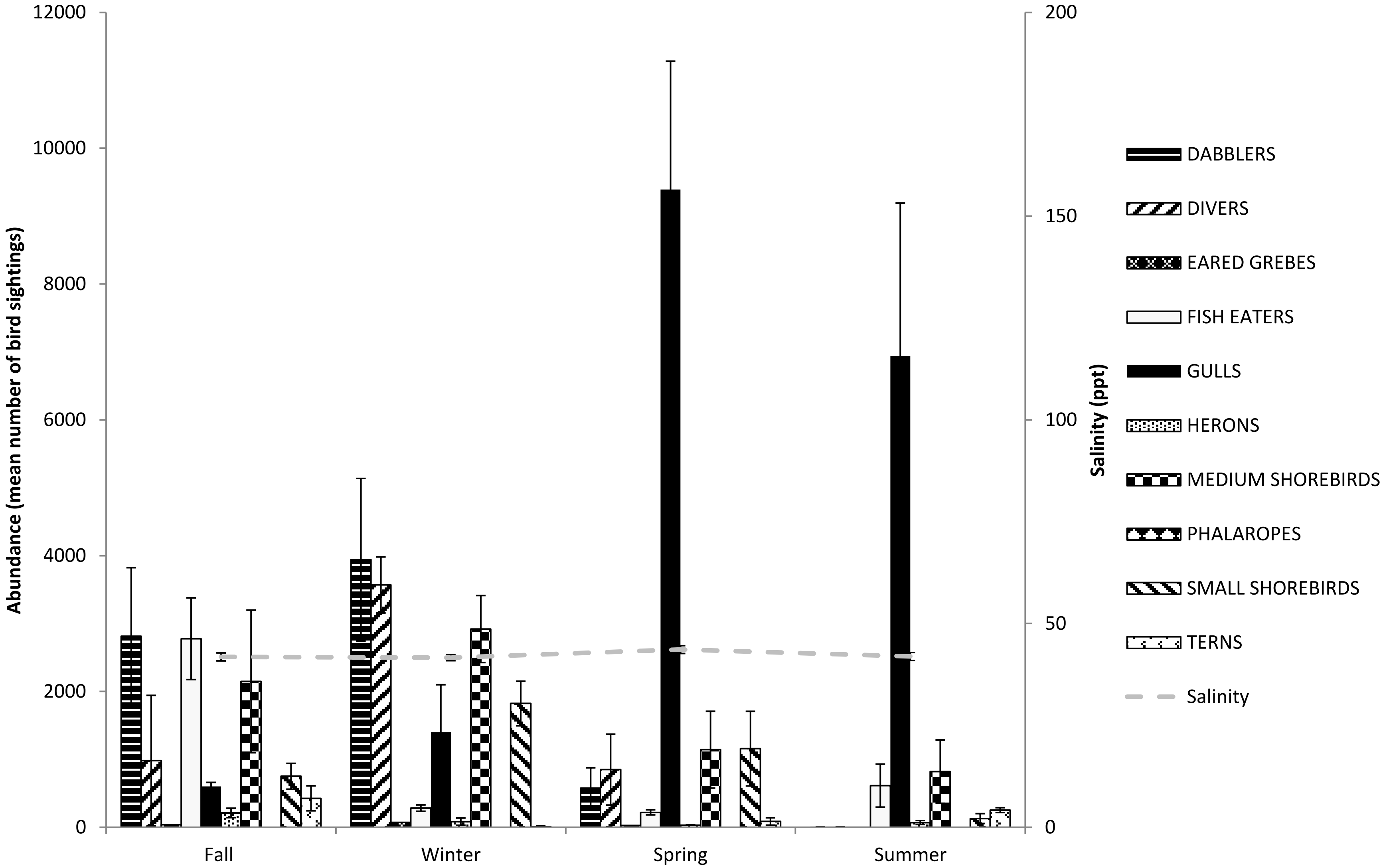


Figure 13. Avian abundance (mean number of bird sightings <u>+</u> 1 SE observed each month) by guild and by season at the Coyote Hills Complex, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. Mean salinity (<u>+</u> 1 SE) in ppt, as measured in this complex, is also indicated for each season (dashed line).

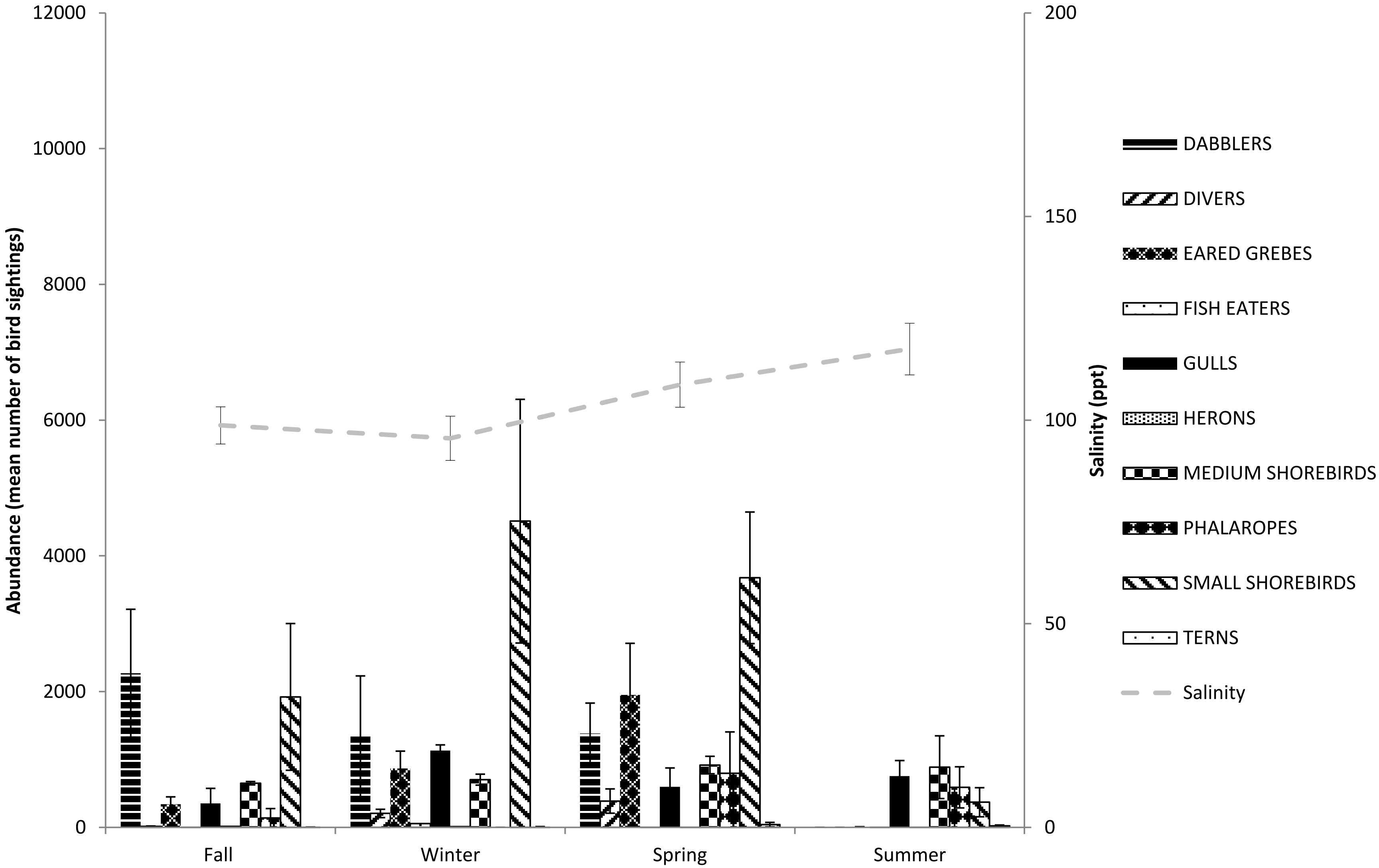


Figure 14. Avian abundance (mean number of bird sightings + 1 SE observed each month) by guild and by season at the Dumbarton Complex, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. Mean salinity (+ 1 SE) in ppt, as measured in this complex, is also indicated for each season (dashed line).

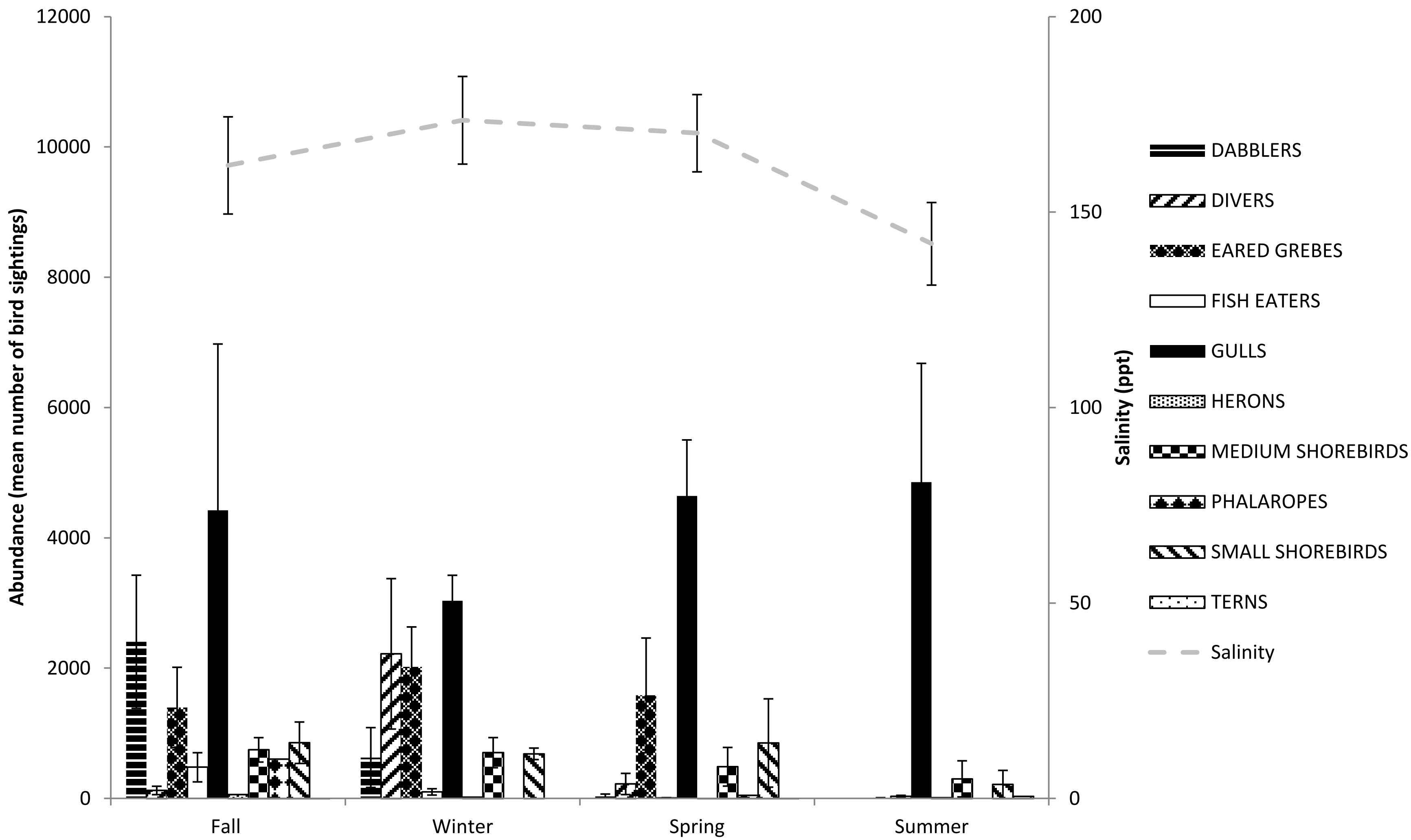


Figure 15. Avian abundance (mean number of bird sightings + 1 SE observed each month) by guild and by season at the Mowry Complex, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012. Mean salinity (+ 1 SE) in ppt, as measured in this complex, is also indicated for each season (dashed line).

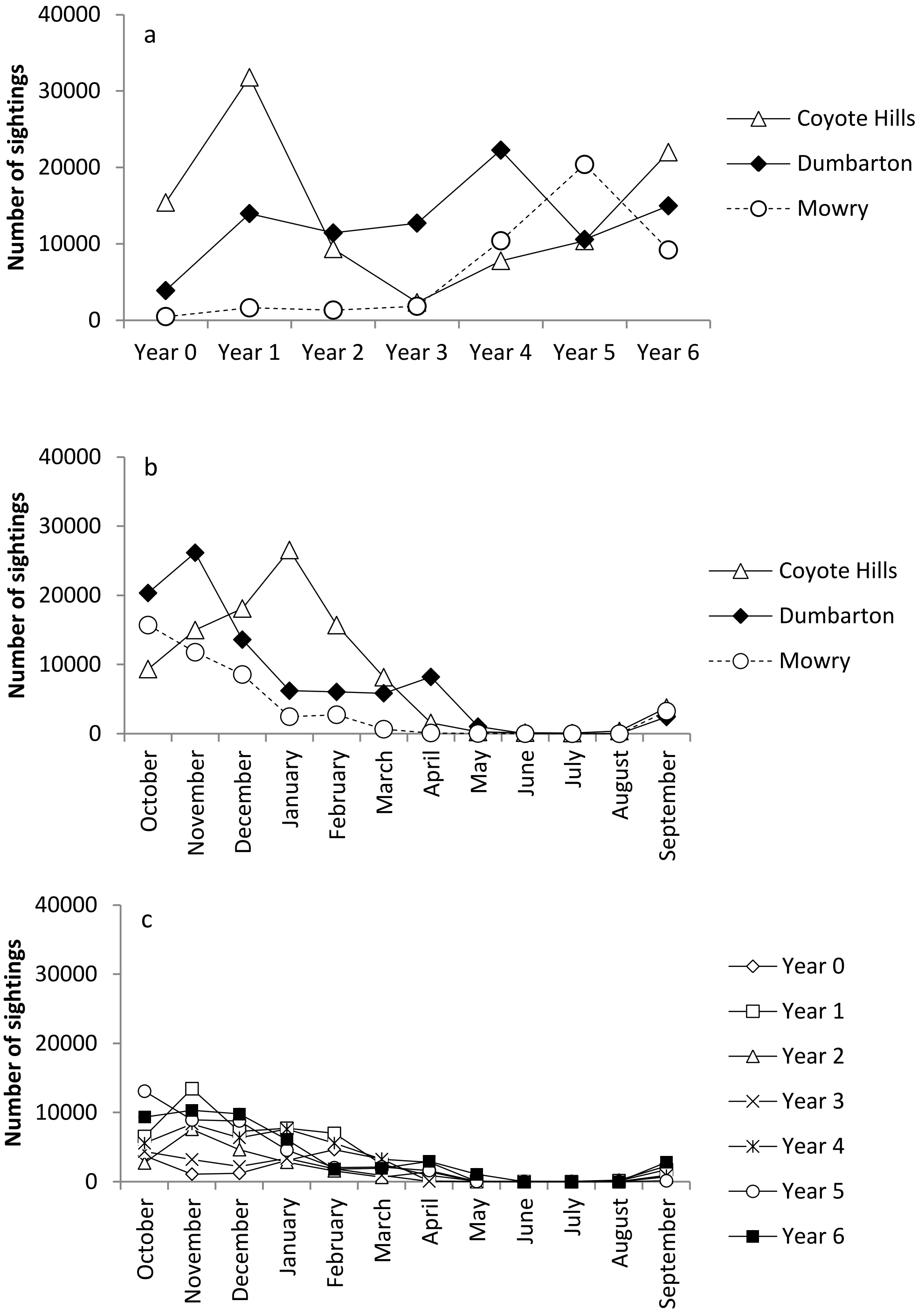


Figure 16. Dabbler abundance by (a) study year for each salt pond complex, (b) month for each salt pond complex during the current study year (Year 6), and (c) month for each study year at Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2005-Sept. 2012. Years were defined as Year 0: Oct. 2005-Sept. 2006, Year 1: Oct. 2006-Sept. 2007, Year 2: Oct. 2007-Sept. 2008, Year 3: Oct. 2008-Sept. 2009, Year 4: Oct. 2009-Sept. 2010, Year 5: Oct. 2010-Sept. 2011, and Year 6: Oct. 2011-Sept. 2012. Salt pond complexes included Coyote Hills, Dumbarton, and Mowry.

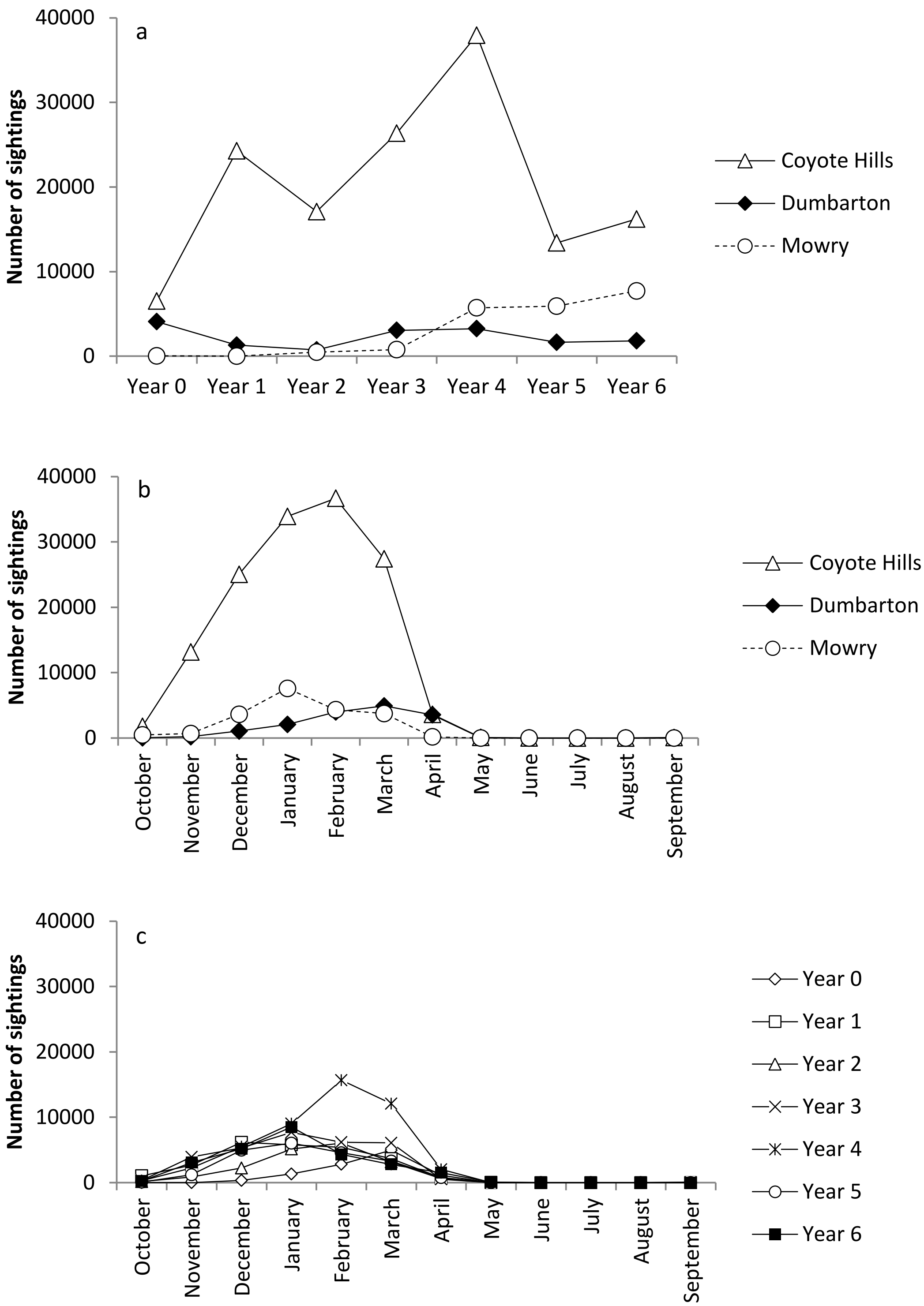
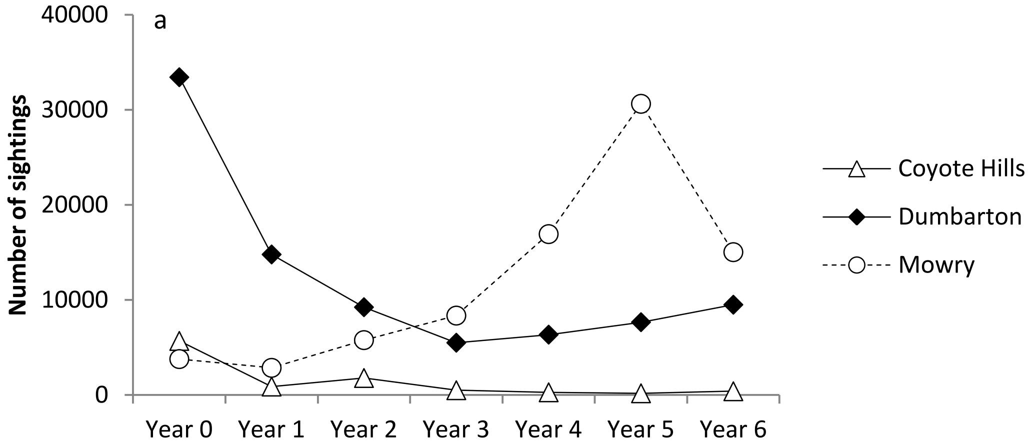
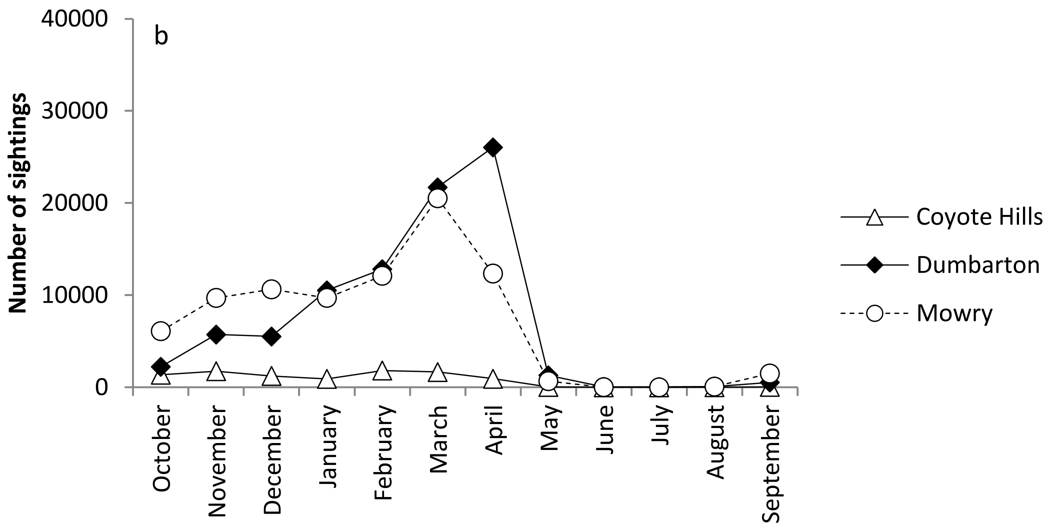


Figure 17. Diver abundance by (a) study year for each salt pond complex, (b) month for each salt pond complex during the current study year (Year 6), and (c) month for each study year at Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2005-Sept. 2012. Years were defined as Year 0: Oct. 2005-Sept. 2006, Year 1: Oct. 2006-Sept. 2007, Year 2: Oct. 2007-Sept. 2008, Year 3: Oct. 2008-Sept. 2009, Year 4: Oct. 2009-Sept. 2010, Year 5: Oct. 2010-Sept. 2011, and Year 6: Oct. 2011-Sept. 2012. Salt pond complexes included Coyote Hills, Dumbarton, and Mowry.





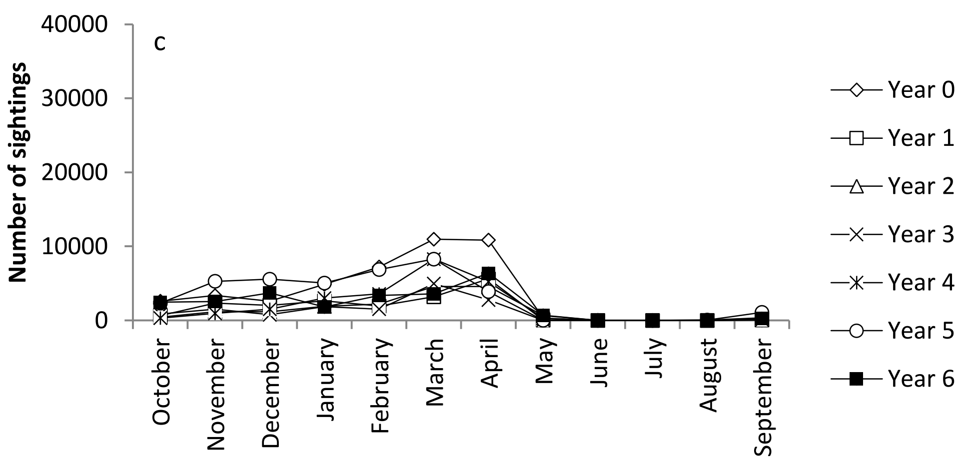


Figure 18. Eared Grebe abundance by (a) study year for each salt pond complex, (b) month for each salt pond complex during the current study year (Year 6), and (c) month for each study year at Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2005-Sept. 2012. Years were defined as Year 0: Oct. 2005-Sept. 2006, Year 1: Oct. 2006-Sept. 2007, Year 2: Oct. 2007-Sept. 2008, Year 3: Oct. 2008-Sept. 2009, Year 4: Oct. 2009-Sept. 2010, Year 5: Oct. 2010-Sept. 2011, and Year 6: Oct. 2011-Sept. 2012. Salt pond complexes included Coyote Hills, Dumbarton, and Mowry.

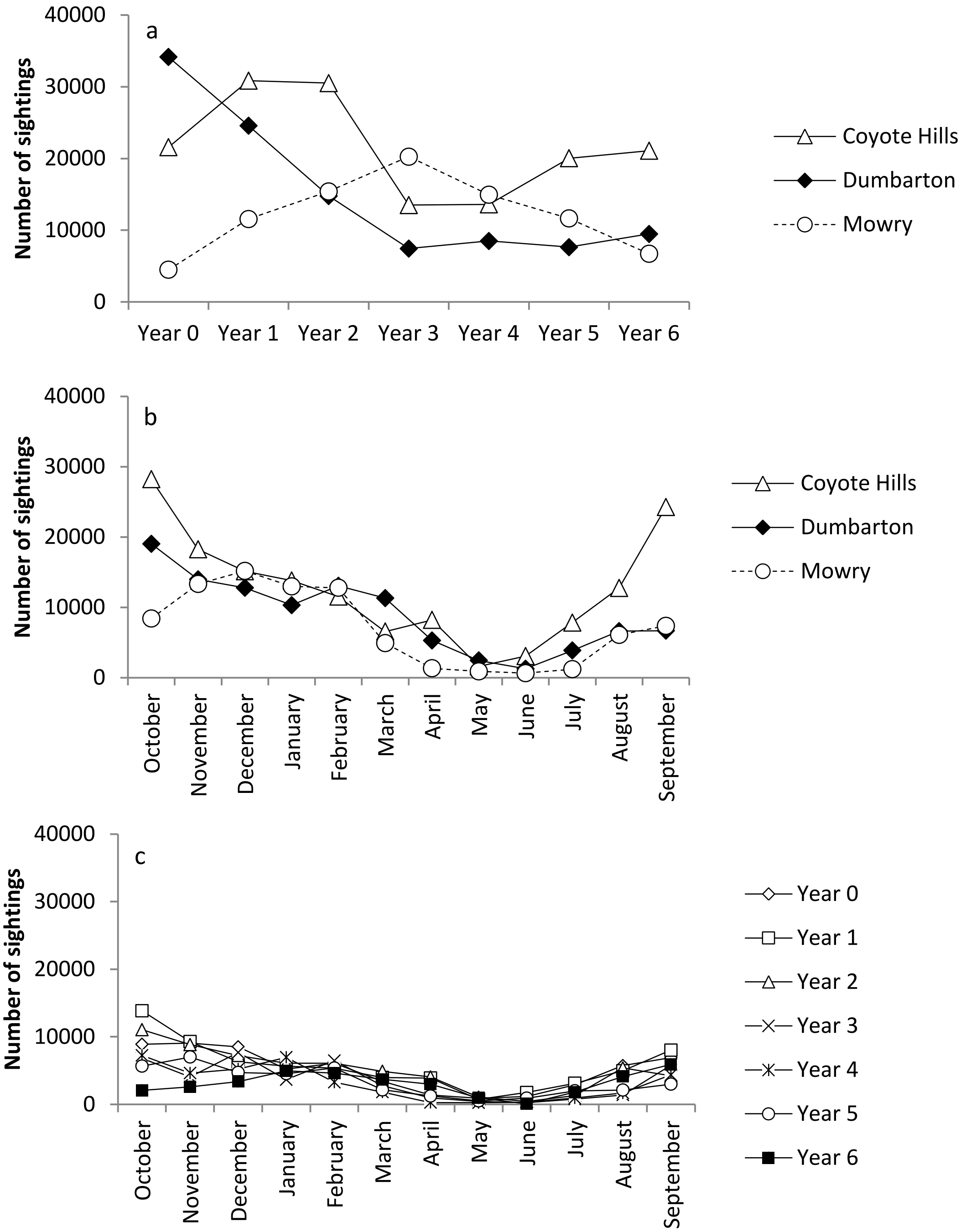


Figure 19. Medium shorebird abundance by (a) study year for each salt pond complex, (b) month for each salt pond complex during the current study year (Year 6), and (c) month for each study year at Don Edwards San Francisco Bay National Wildlife Refuge, South San, Francisco Bay, California, Oct. 2005-Sept. 2012. Years were defined as Year 0: Oct. 2005-Sept. 2006, Year 1: Oct. 2006-Sept. 2007, Year 2: Oct. 2007-Sept. 2008, Year 3: Oct. 2008-Sept. 2009, Year 4: Oct. 2009-Sept. 2010, Year 5: Oct. 2010-Sept. 2011, and Year 6: Oct. 2011-Sept. 2012. Salt pond complexes included Coyote Hills, Dumbarton, and Mowry.

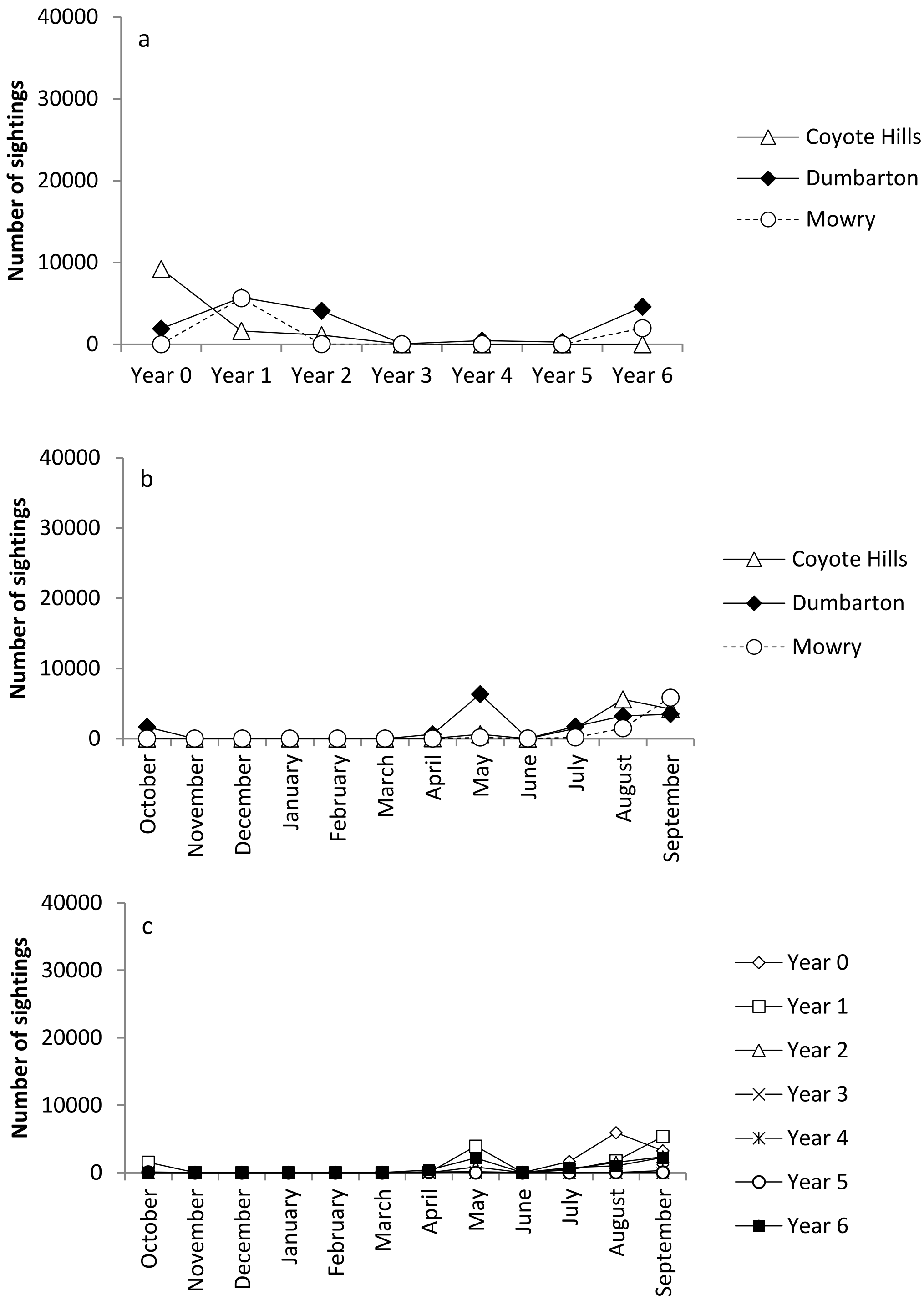


Figure 20. Phalarope abundance by (a) study year for each salt pond complex, (b) month for each salt pond complex during the current study year (Year 6), and (c) month for each study year at Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2005-Sept. 2012. Years were defined as Year 0: Oct. 2005-Sept. 2006, Year 1: Oct. 2006-Sept. 2007, Year 2: Oct. 2007-Sept. 2008, Year 3: Oct. 2008-Sept. 2009, Year 4: Oct. 2009-Sept. 2010, Year 5: Oct. 2010-Sept. 2011, and Year 6: Oct. 2011-Sept. 2012. Salt pond complexes included Coyote Hills, Dumbarton, and Mowry.

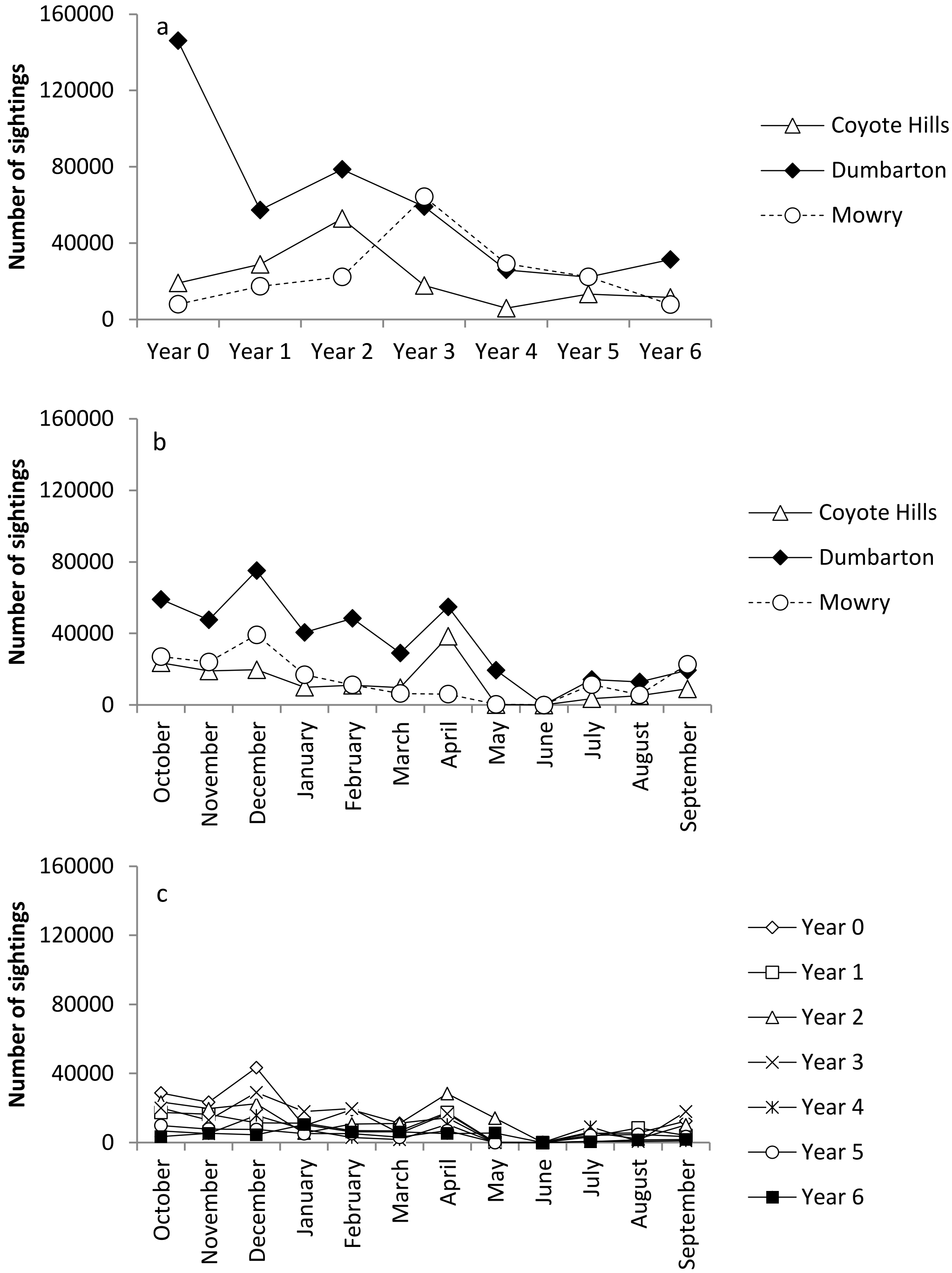


Figure 21. Small shorebird abundance by (a) study year for each salt pond complex, (b) month for each salt pond complex during the current study year (Year 6), and (c) month for each study year at Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2005-Sept. 2012. Years were defined as Year 0: Oct. 2005-Sept. 2006, Year 1: Oct. 2006-Sept. 2007, Year 2: Oct. 2007-Sept. 2008, Year 3: Oct. 2008-Sept. 2009, Year 4: Oct. 2009-Sept. 2010, Year 5: Oct. 2010-Sept. 2011, and Year 6: Oct. 2011-Sept. 2012. Salt pond complexes included Coyote Hills, Dumbarton, and Mowry.

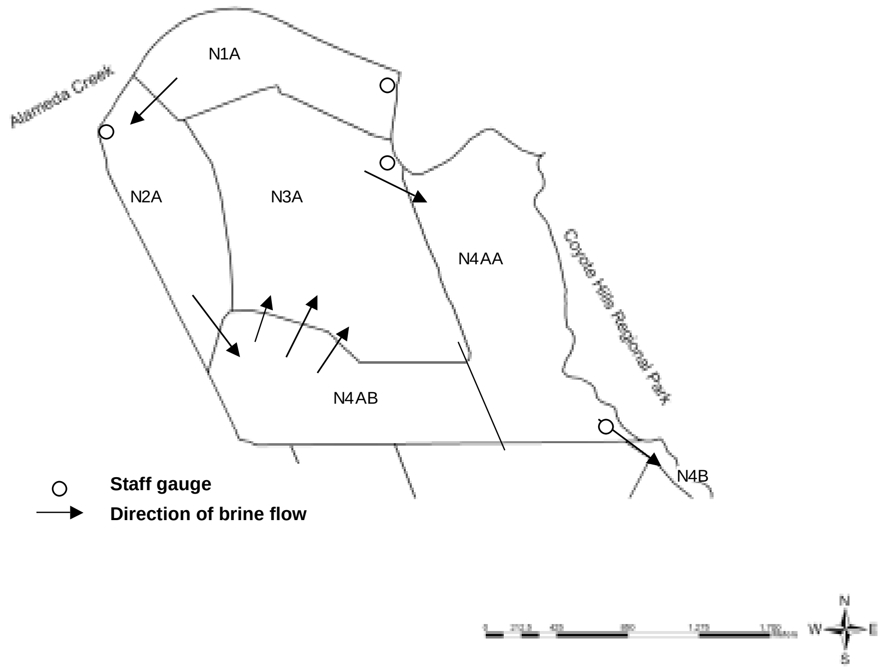


Figure 22. North Coyote Hills ponds diagram, showing staff gauge locations and direction of brine flow (reproduced from Murphy et al. 2007). Notes: Flow of brines may vary depending on Cargill Salt's business and/or operational needs. Ponds N4AA and N4AB are considered a single pond by Cargill Salt and are collectively referred to as *Concentrator 4A*.

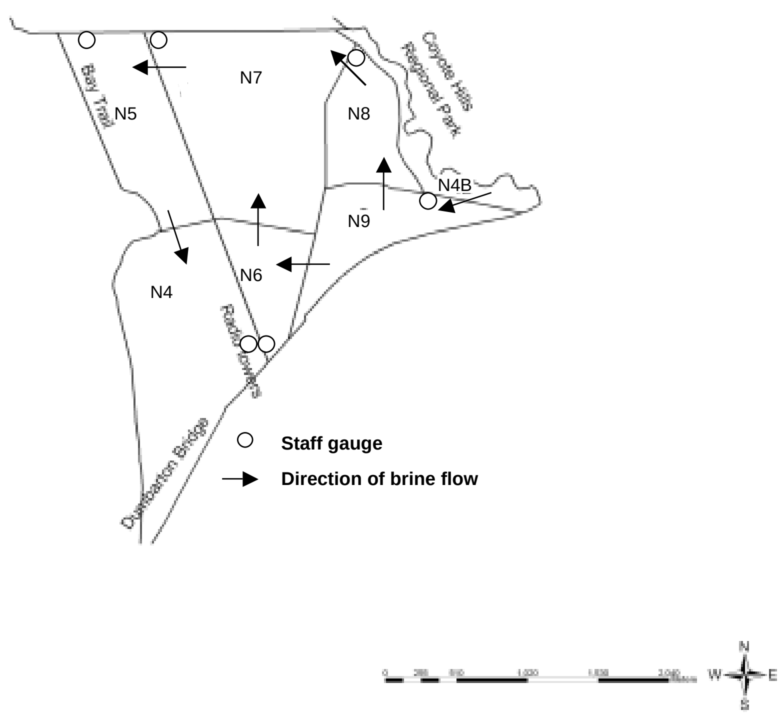


Figure 23. South Coyote Hills ponds diagram, showing staff gauge locations and direction of brine flow (reproduced from Murphy et al. 2007). Note: Flow of brines may vary depending on Cargill Salt's business and/or operational needs.

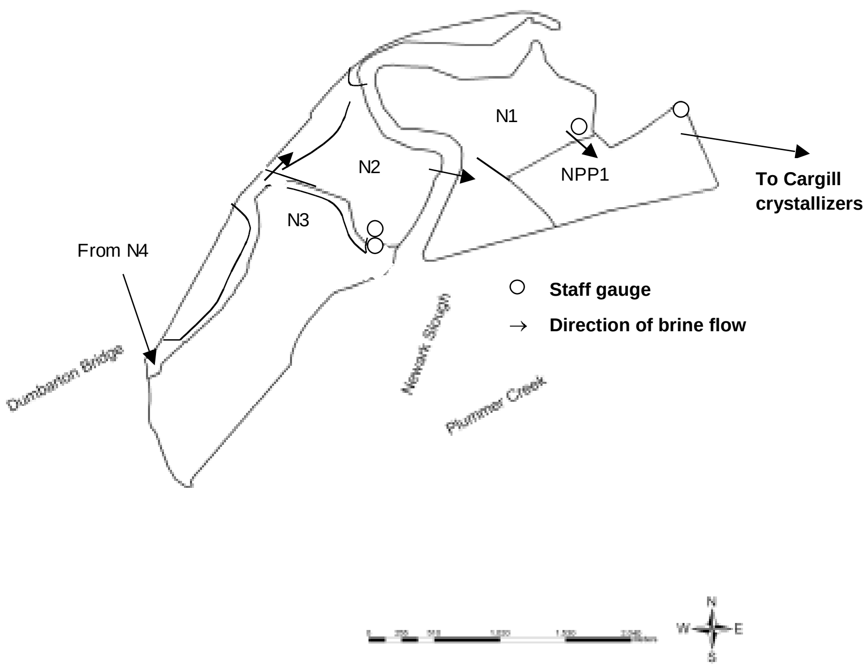


Figure 24. Dumbarton ponds diagram, showing staff gauge locations and direction of brine flow (reproduced from Murphy et al. 2007). Note: Flow of brines may vary depending on Cargill Salt's business and/or operational needs.

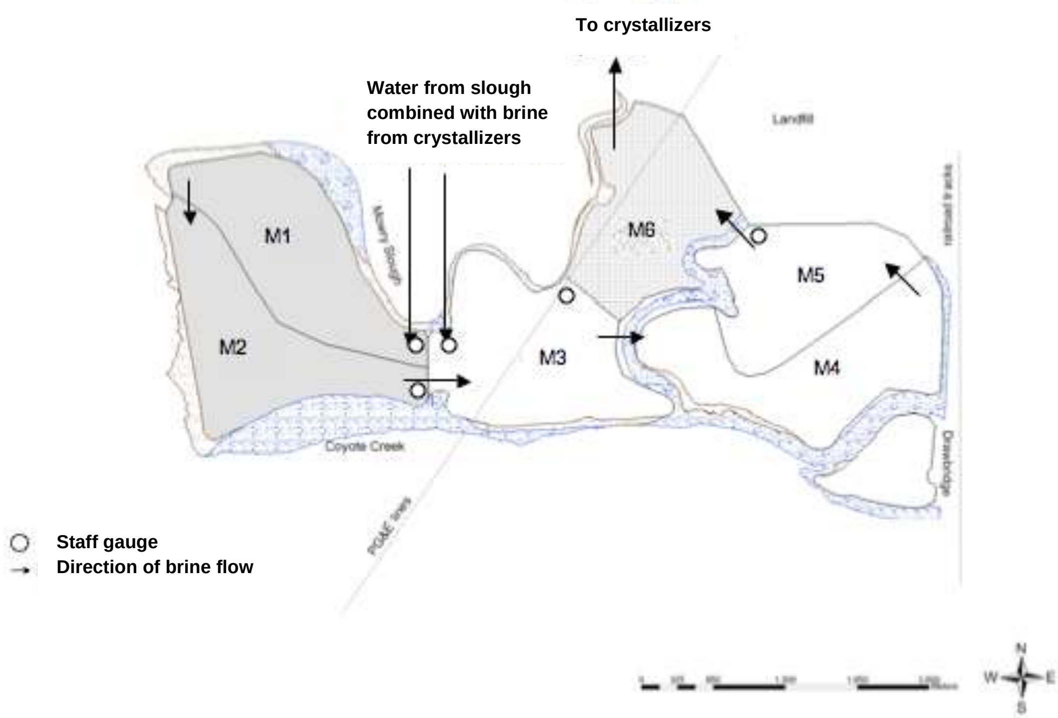


Figure 25. Mowry ponds diagram, showing staff gauge locations and direction of brine flow (reproduced from Murphy et al. 2007). Note: Flow of brines may vary depending on Cargill Salt's business and/or operational needs.

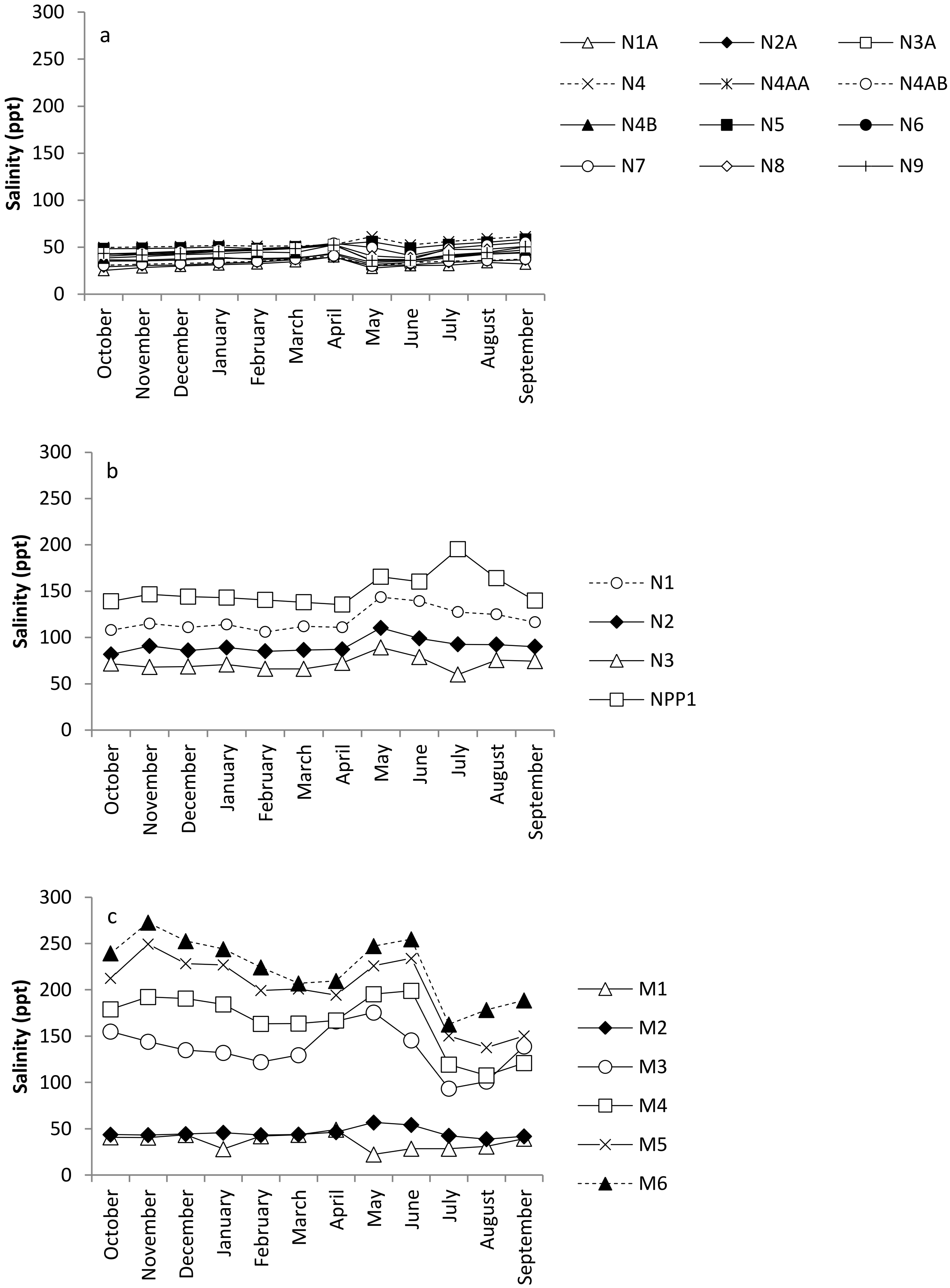


Figure 26. Average monthly salinity at (a) Coyote Hills, (b) Dumbarton, and (c) Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

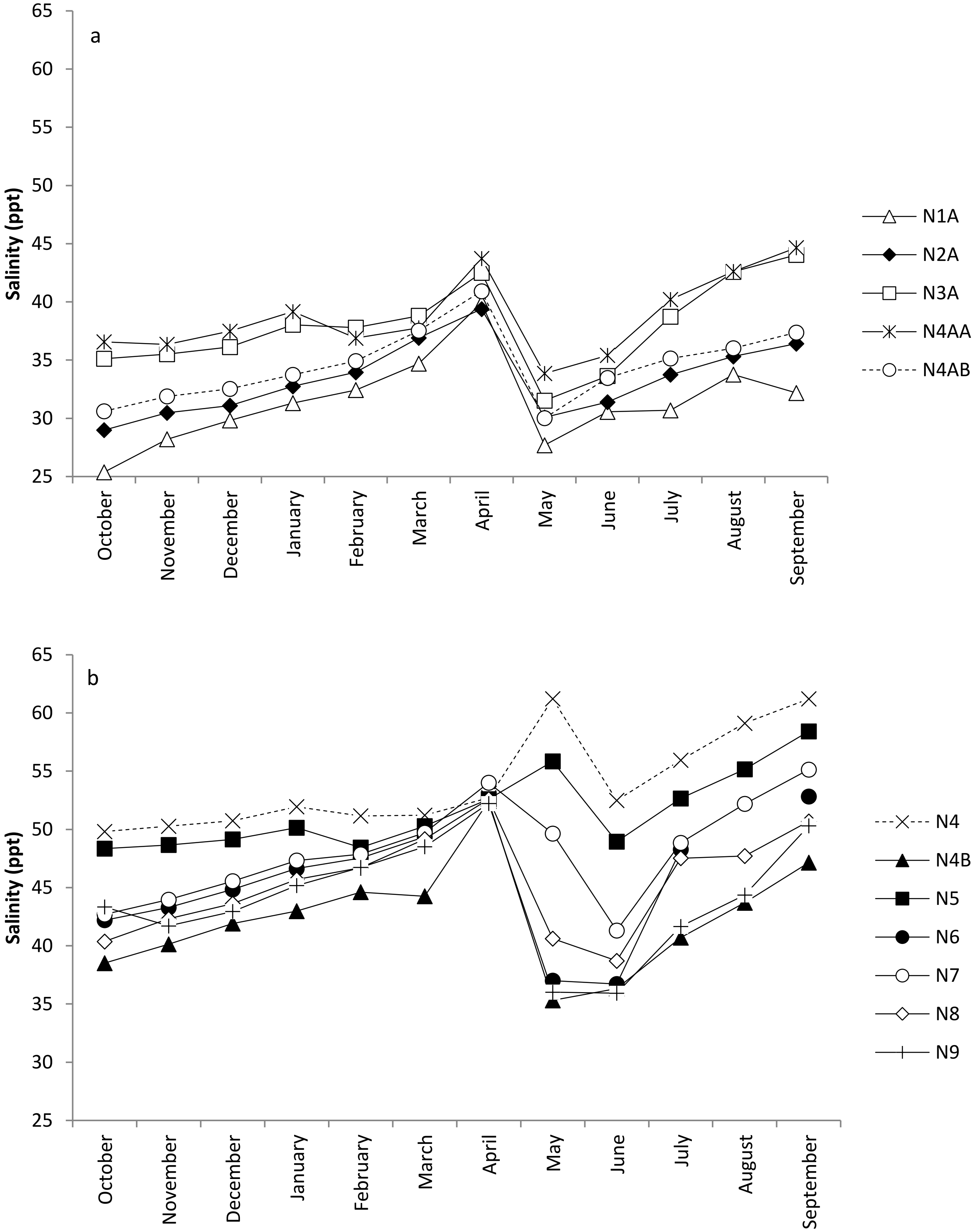


Figure 27. Average monthly salinity at (a) northern Coyote Hills ponds and (b) southern Coyote Hills ponds, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

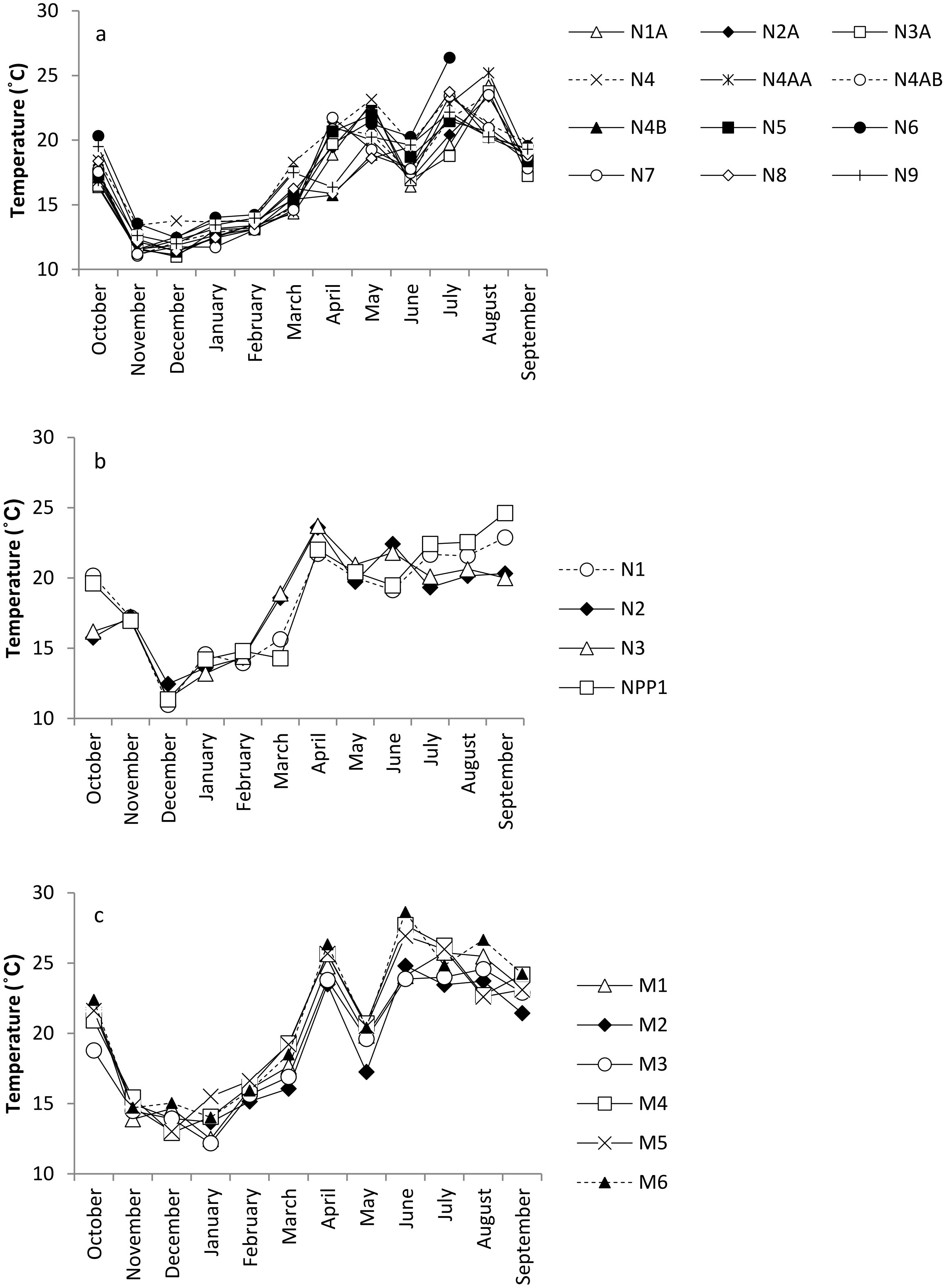


Figure 28. Average monthly temperature (degrees Celsius) at (a) Coyote Hills, (b) Dumbarton, and (c) Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

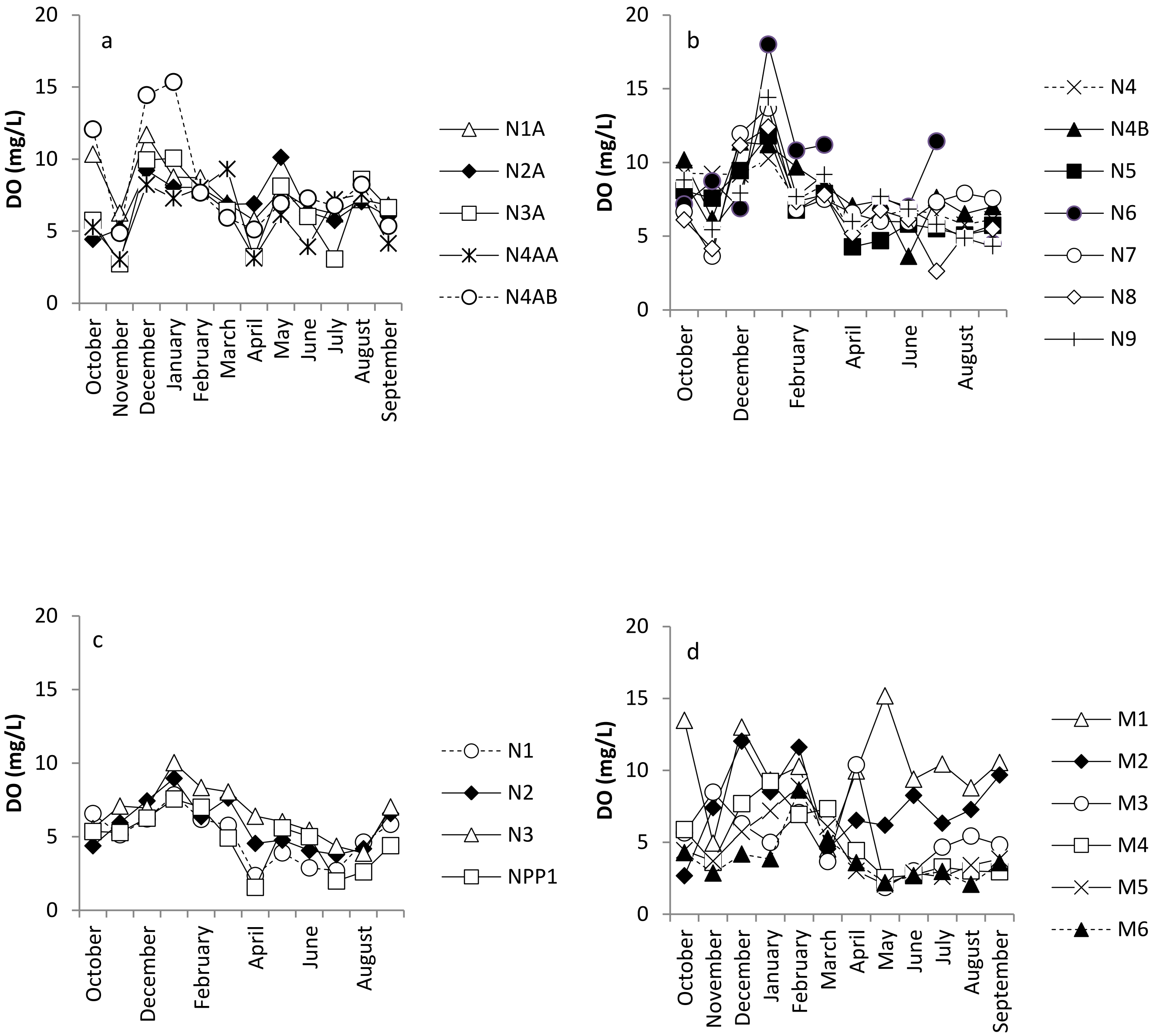


Figure 29. Average monthly dissolved oxygen (mg/L) at (a) northern Coyote Hills ponds, (b) southern Coyote Hills ponds, (c) Dumbarton ponds, and (d) Mowry ponds, South San Francisco Bay, Don Edwards San Francisco Bay National Wildlife Refuge, California, Oct. 2011-Sept. 2012.

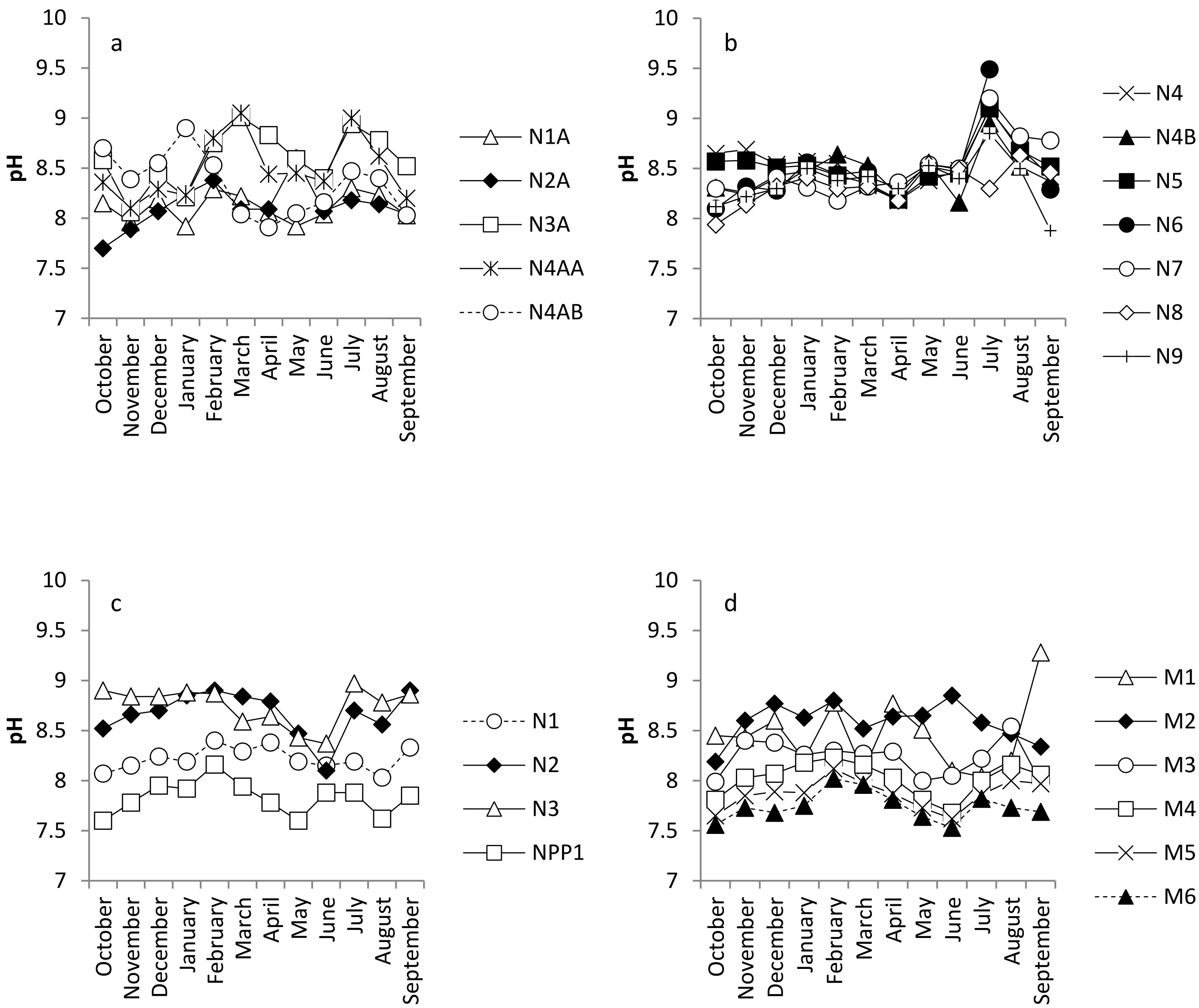


Figure 30. Average monthly pH at (a) northern Coyote Hills ponds, (b) southern Coyote Hills ponds, (c) Dumbarton ponds, and (d) Mowry ponds, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

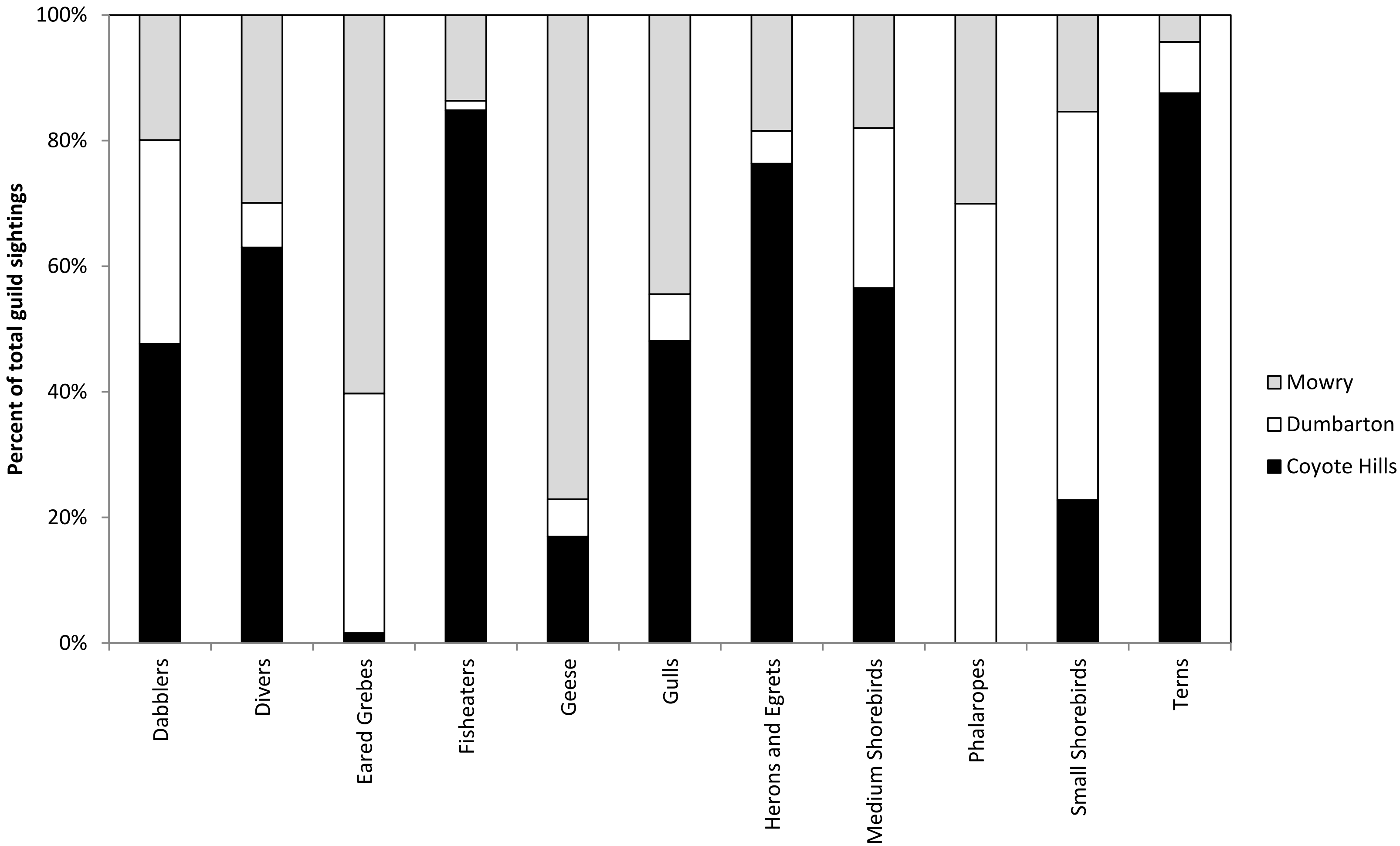


Figure 31. Percentage of total guild sightings by complex (Coyote Hills, Dumbarton, and Mowry), Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, California, Oct. 2011-Sept. 2012.

Appendix I. Species assignments to foraging guilds. Guilds included dabblers, divers, Eared Grebes, fisheaters, flamingos, geese, gulls, herons, medium shorebirds, phalaropes, small shorebirds, and terns.

Common Name	**Scientific Name**	**Guild**
American Coot	*Fulica americana*	Dabbler
American Green-winged Teal	*Anas crecca*	Dabbler
American Wigeon	*Anas americana*	Dabbler
Blue-winged Teal	*Anas discors*	Dabbler
Cinnamon Teal	*Anas cyanoptera*	Dabbler
Common Moorhen	*Gallinula chloropus*	Dabbler
Domestic Mallard	*Anas* spp	Dabbler
Eurasian Wigeon	*Anas penelope*	Dabbler
Gadwall	*Anas strepera*	Dabbler
Green-winged Teal	*Anas crecca*	Dabbler
Long-tailed Duck	*Clangula hyemalis*	Dabbler
Mallard	*Anas platyrhynchos*	Dabbler
Northern Pintail	*Anas acuta*	Dabbler
Northern Shoveler	*Anas clypeata*	Dabbler
Unidentified dabbling duck	dabbling duck spp.	Dabbler
Barrow's Goldeneye	*Bucephala islandica*	Diver
Bufflehead	*Bucephala albeola*	Diver
Canvasback	*Aythya valisineria*	Diver
Common Goldeneye	*Bucephala clangula*	Diver
Greater Scaup	*Aythya marila*	Diver
Lesser Scaup	*Aythya affinis*	Diver
Redhead	*Aythya americana*	Diver
Ring-necked Duck	*Aythya collaris*	Diver
Ruddy Duck	*Oxyura jamaicensis*	Diver
Surf Scoter	*Melanitta perspicillata*	Diver
Tufted Duck	*Aythya fuligula*	Diver
Unidentified diving duck	*diving duck* spp.	Diver
Unidentified scaup	*Aythya* spp.	Diver
White-winged scoter	*Melanitta fusca*	Diver
Eared Grebe	*Podiceps nigricollis*	Eared Grebe
American White Pelican	*Pelecanus erythrorhynchos*	Fisheater
Belted Kingfisher	*Ceryle alcyon*	Fisheater
Black Skimmer	*Rhynchops niger*	Fisheater
Brown Booby	*Sula leucogaster*	Fisheater
Brown Pelican	*Pelecanus occidentalis*	Fisheater
Clark's Grebe	*Aechmophorus clarkii*	Fisheater
Common Loon	*Gavia immer*	Fisheater
Common Merganser	*Mergus merganser*	Fisheater
Double-crested Cormorant	*Phalacrocorax auritus*	Fisheater
Hooded Merganser	*Lophodytes cucullatus*	Fisheater
Horned Grebe	*Podiceps auritus*	Fisheater
Long-tailed Jaeger	*Stercorarius longicaudus*	Fisheater

Pacific Loon	*Gavia pacifica*	Fisheater
Pelagic Cormorant	*Phalacrocorax pelagicus*	Fisheater
Pied-billed Grebe	*Podilymbus podiceps*	Fisheater
Red-breasted Merganser	*Mergus serrator*	Fisheater
Red-necked Grebe	*Podiceps grisegena*	Fisheater
Red-throated Loon	*Gavia stellata*	Fisheater
Unidentified Cormorant	*Phalacrocorax spp*	Fisheater
Unidentified grebe		Fisheater
Western Grebe	*Aechmophorus occidentalis*	Fisheater
Western Grebe or Clark's Grebe	*Aechmophorus* spp.	Fisheater
Chilean Flamingo	*Phoenicopterus chilensis*	Flamingo
Greater Flamingo	*Phoenicopterus ruber*	Flamingo
Black Brant	*Branta bernicla nigricans*	Goose
Canada Goose	*Branta canadensis*	Goose
Greater White-fronted Goose	*Anser albifrons*	Goose
Mute Swan	*Cygnus olor*	Goose
Snow Goose	*Chen caerulescens*	Goose
Trumpeter Swan	*Cygnus buccinator*	Goose
Tundra Swan	*Cygnus columbianus*	Goose
Bonaparte's Gull	*Larus philadelphia*	Gull
California Gull	*Larus californicus*	Gull
California Gull or Ring-billed Gull	*Larus* spp.	Gull
Franklin's Gull	*Larus pipixcan*	Gull
Glaucous Gull	*Larus hyperboreus*	Gull
Glaucous-winged Gull	*Larus glaucescens*	Gull
Herring Gull	*Larus argentatus*	Gull
Mew Gull	*Larus canus*	Gull
Ring-billed Gull	*Larus delawarensis*	Gull
Sabine's Gull	*Xena sabini*	Gull
Slaty-backed Gull	*Larus schistisagus*	Gull
Thayer's Gull	*Larus thayeri*	Gull
Unidentified gull	*Larus* spp.	Gull
Western Gull	*Larus occidentalis*	Gull
American Bittern	*Botarus lentiginosus*	Heron
Black-crowned Night-Heron	*Nycticorax nycticorax*	Heron
Cattle Egret	*Bubulcus ibis*	Heron
Great Blue Heron	*Ardea herodias*	Heron
Great Egret	*Ardea alba*	Heron
Green Heron	*Butorides virescens*	Heron
Little Blue Heron	*Egretta caerulea*	Heron
Snowy Egret	*Egretta thula*	Heron
White-faced Ibis	*Plegadis chihi*	Heron
American Avocet	*Recurvirostra americana*	Medium shorebird
Black Oystercatcher	*Haematopus bachmani*	Medium shorebird
Black Turnstone	*Arenaria melanocephala*	Medium shorebird
Black-bellied Plover	*Pluvialis squatarola*	Medium shorebird

Black-necked Stilt	*Himantopus mexicanus*	Medium shorebird
Common Snipe	*Gallinago gallinago*	Medium shorebird
Golden Plover	*Pluvialis* spp.	Medium shorebird
Greater Yellowlegs	*Tringa melanoleuca*	Medium shorebird
Killdeer	*Charadrius vociferus*	Medium shorebird
Lesser Yellowlegs	*Tringa flavipes*	Medium shorebird
Long-billed Curlew	*Numenius americanus*	Medium shorebird
Marbled Godwit	*Limosa fedoa*	Medium shorebird
Pacific Golden-Plover	*Pluvialis fulva*	Medium shorebird
Red Knot	*Calidris canutus*	Medium shorebird
Ruddy Turnstone	*Arenaria interpres*	Medium shorebird
Ruff	*Philomachus pugnax*	Medium shorebird
Spotted Redshank	*Tringa erythropus*	Medium shorebird
Stilt Sandpiper	*Calidris himantopus*	Medium shorebird
Surfbird	*Aphriza virgata*	Medium shorebird
Unidentifed yellowlegs	*Tringa* spp.	Medium shorebird
Unidentified medium shorebird	*med shorebird* spp.	Medium shorebird
Wandering Tattler	*Tringa incana*	Medium shorebird
Whimbrel	*Numenius phaeopus*	Medium shorebird
Willet	*Catoptrophorus semipalmatus*	Medium shorebird
Red Phalarope	*Phalaropus fulicaria*	Phalarope
Red-necked Phalarope	*Phalaropus lobatus*	Phalarope
Unidentified phalarope	*Phalaropus spp.*	Phalarope
Wilson's Phalarope	*Phalaropus tricolor*	Phalarope
California Black Rail	*Laterallus jamaicensis coturniculus*	Rail
Clapper Rail	*Rallus longirostris*	Rail
Sora	*Porzana carolina*	Rail
Unidentified rail		Rail
Virginia Rail	*Rallus limicola*	Rail
Baird's Sandpiper	*Calidris bairdii*	Small shorebird
Dunlin	*Calidris alpina*	Small shorebird
Least Sandpiper	*Calidris minutilla*	Small shorebird
Long-billed Dowitcher	*Limnodromus scolopaceus*	Small shorebird
Pectoral Sandpiper	*Calidris melanotos*	Small shorebird
Sanderling	*Calidris alba*	Small shorebird
Semipalmated Plover	*Charadrius semipalmatus*	Small shorebird
Semipalmated Sandpiper	*Calidris pusilla*	Small shorebird
Short-billed Dowitcher	*Limnodromus griseus*	Small shorebird
Snowy Plover	*Charadrius alexandrinus*	Small shorebird
Spotted Sandpiper	*Actitis macularia*	Small shorebird
Unidentified Dowitcher	*Limnodromus* spp.	Small shorebird
Unidentified peeps	*Calidris* spp.	Small shorebird
Western Sandpiper	*Calidris mauri*	Small shorebird
Western Sandpiper or Dunlin	*Calidris* spp.	Small shorebird
Western Sandpiper or Least Sandpiper	*Calidris* spp.	Small shorebird
Arctic Tern	*Sterna paradisaea*	Tern

Black Tern	*Chlidonias niger*	Tern
Caspian Tern	*Sterna caspia*	Tern
Common Tern	*Sterna hirundo*	Tern
Elegant Tern	*Sterna elegans*	Tern
Forster's Tern	*Sterna forsteri*	Tern
Least Tern	*Sterna antillarum browni*	Tern
Unidentified tern	*Sterna* spp.	Tern